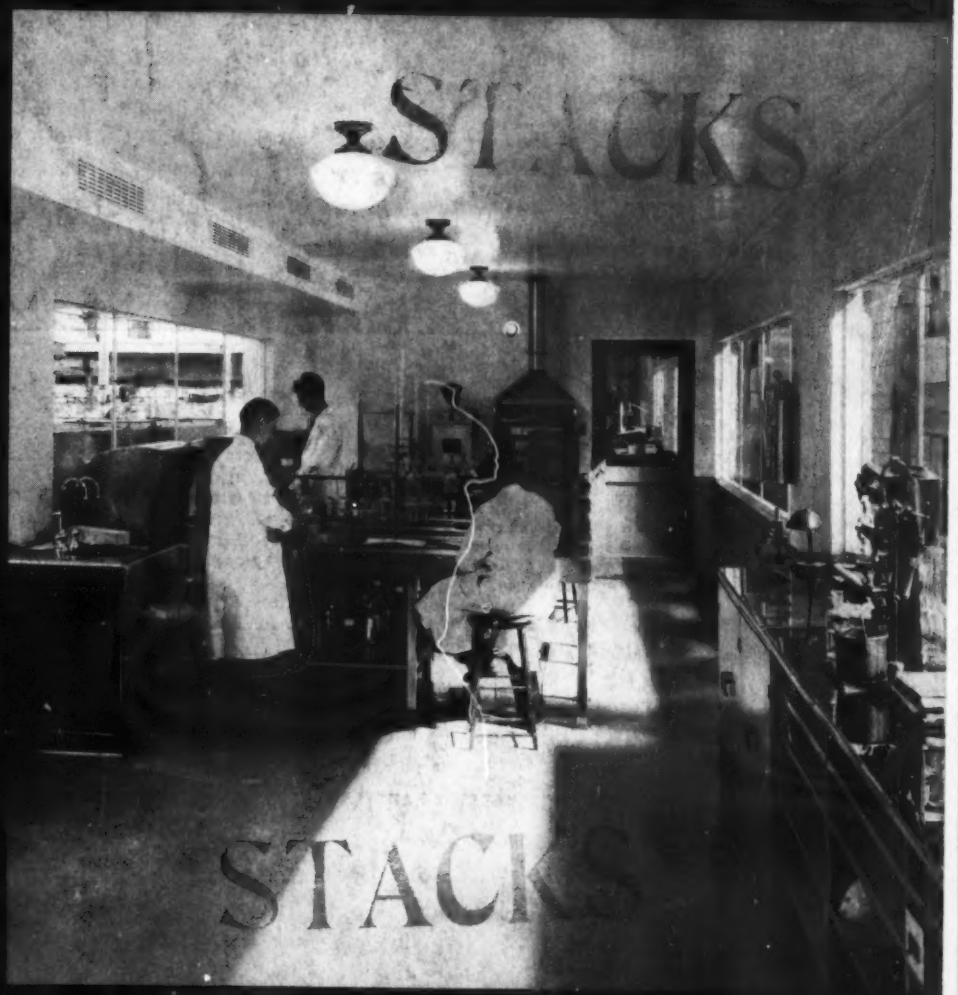
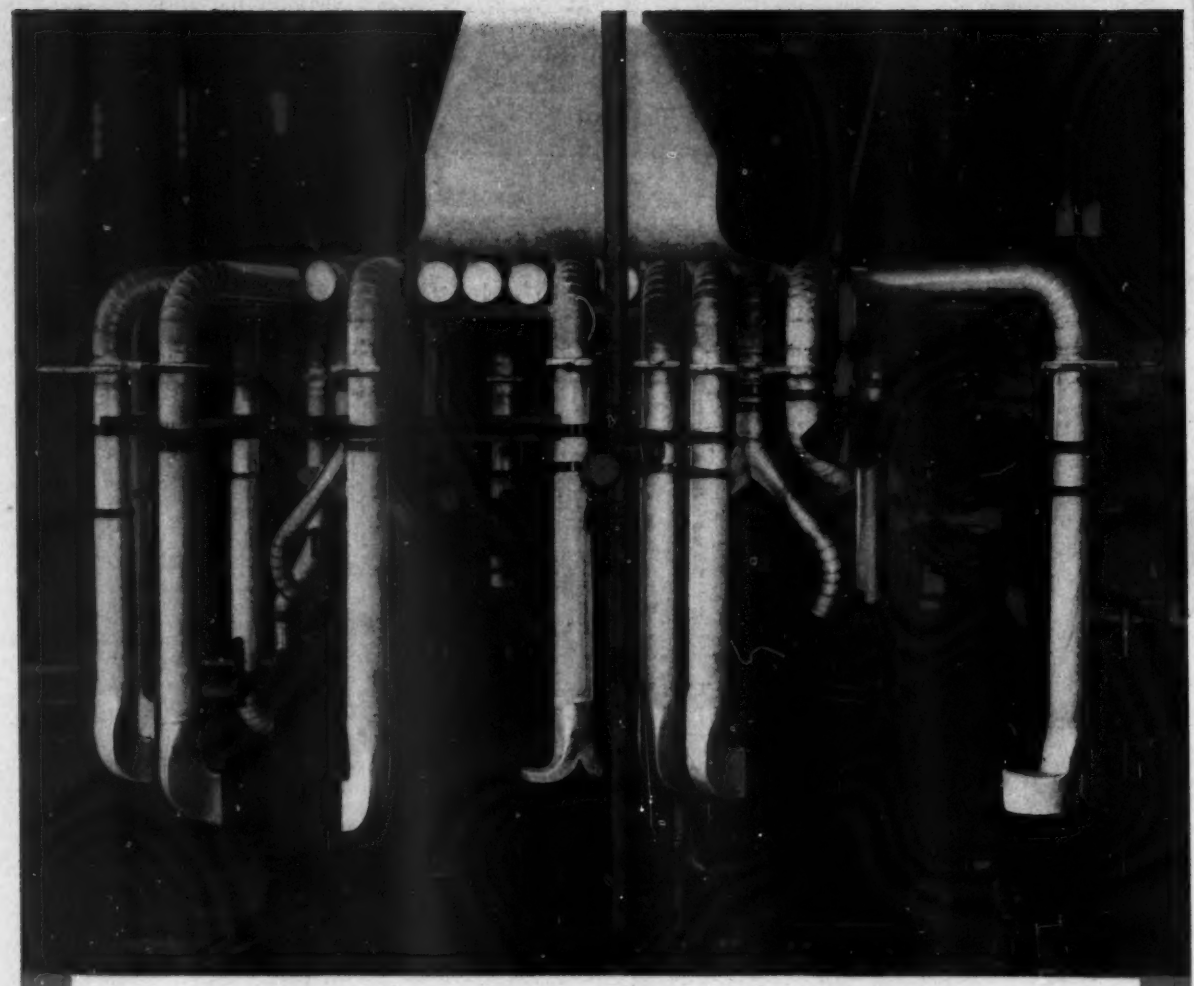
# *the* glass industry





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K & B Engineers have made an exhaustive study of the proper application of wind systems for mould, conveyor and man cooling on the Lynch No. 10 and other types of bottle and Ware machines, and have developed a standard head for most of them. Why not take advantage of this experience and knowledge by requesting us to make a survey of your plant, just as we have done for the following: Ball Bros., Hazel-Atlas Glass Co., Owens-Illinois Glass Co., General Glass Co., Knox Glass Bottle Co., Fourco Glass Co., Chattanooga Glass Bottle Co., Federal Glass Co., Maryland Glass Co., Buck Glass Co.

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# the glass industry

*Devoted to glass technology, engineering, material and glass factory equipment and operation*

PUBLISHED AT 11 WEST 42ND STREET, NEW YORK, N. Y., BY OGDEN-WATNEY PUBLISHERS, INC.

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N. A.

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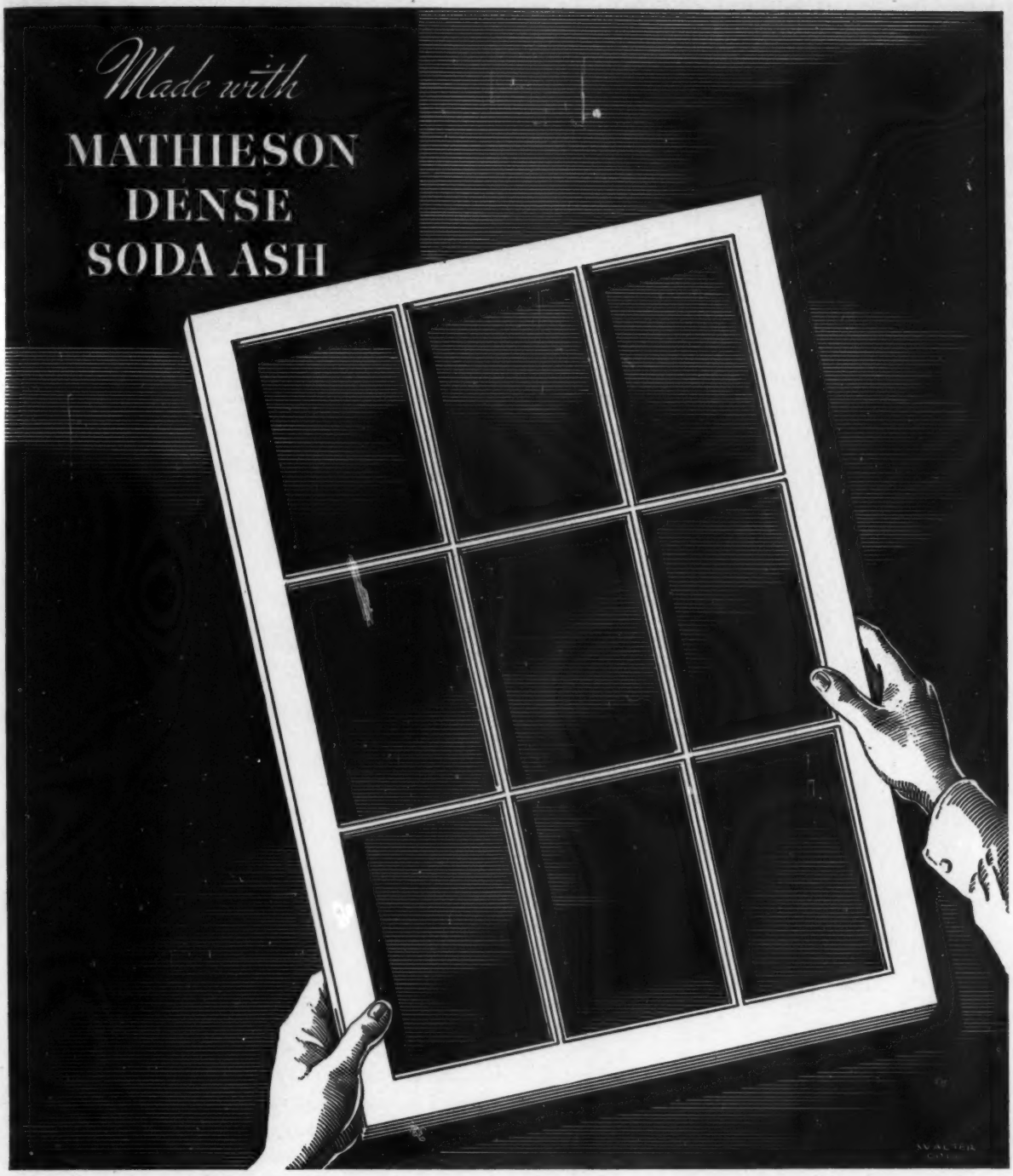


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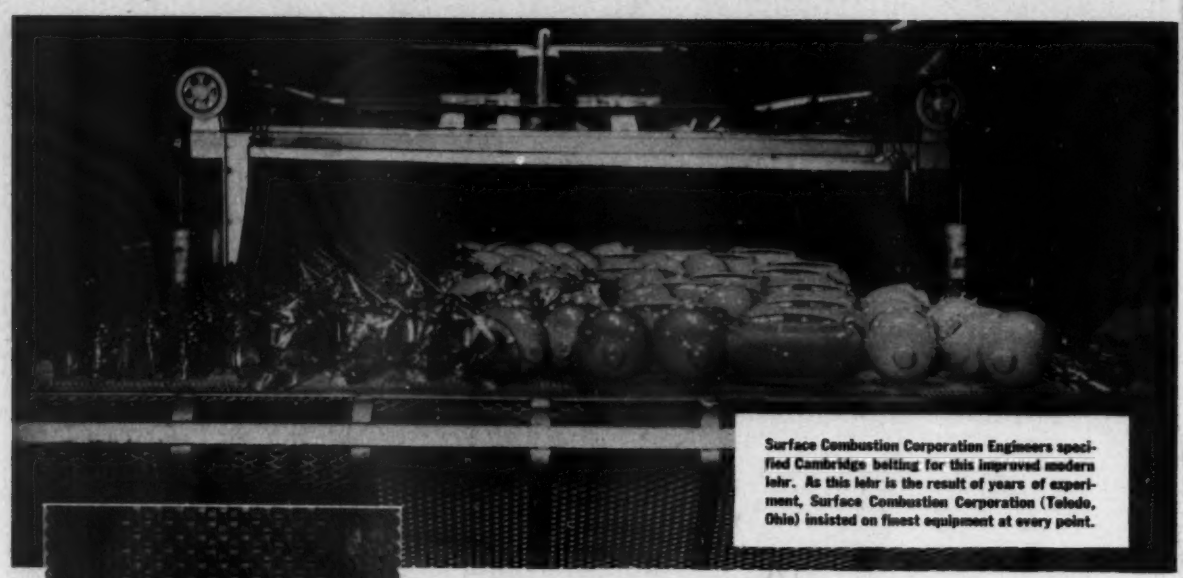

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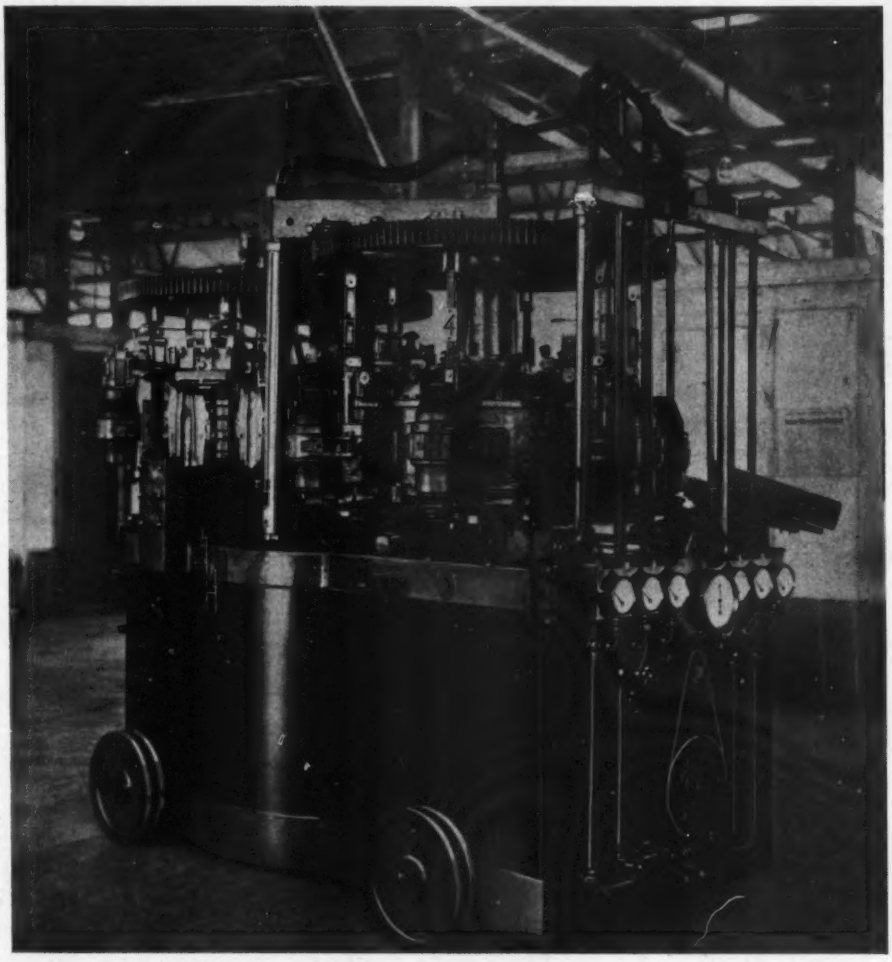

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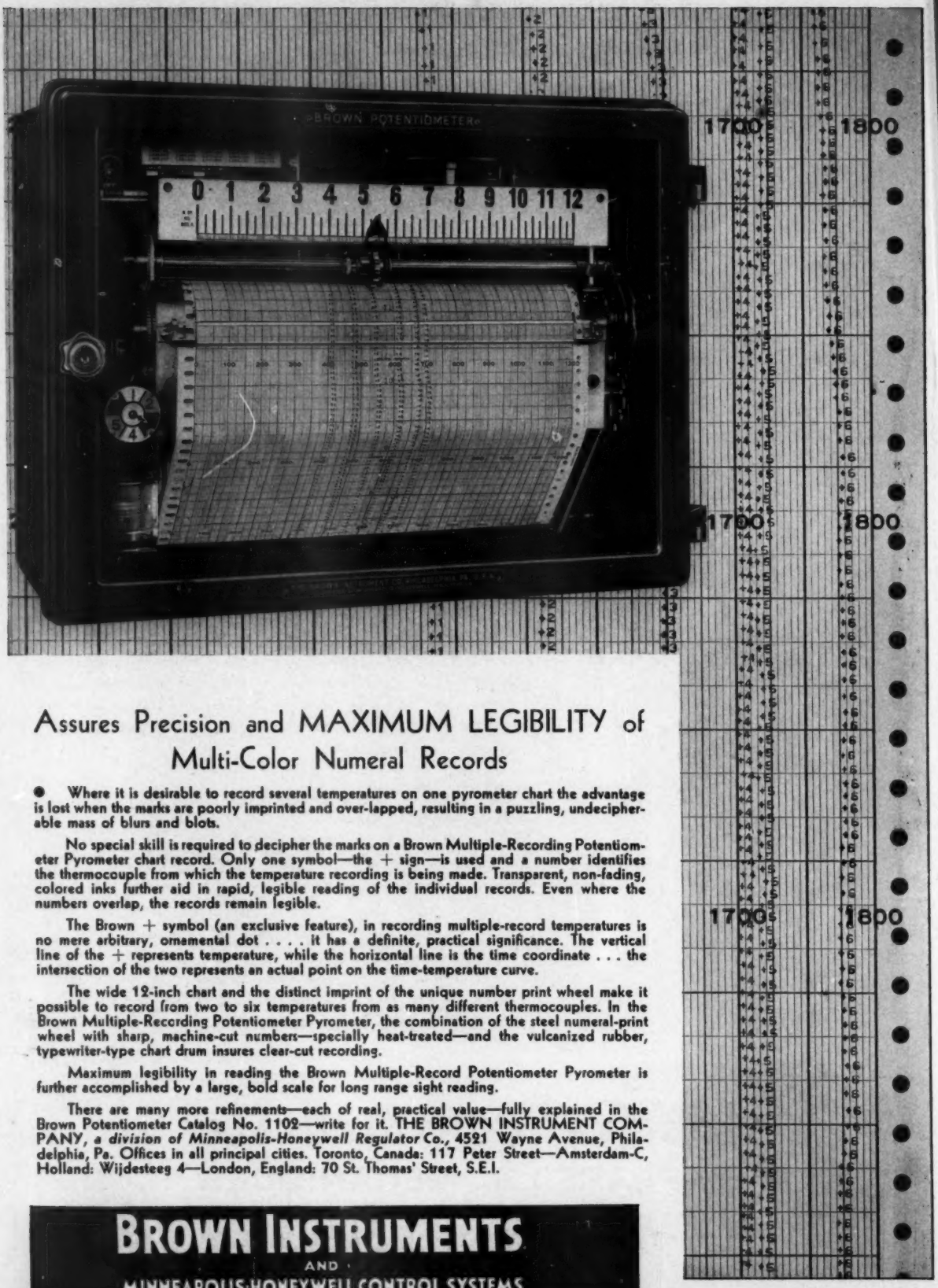
**SOCIÉTÉ CONTINENTALE D'APPAREILS MÉCANIQUES POUR LA VERRERIE S. A.**

**BASEL, SWITZERLAND**

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● Where it is desirable to record several temperatures on one pyrometer chart the advantage is lost when the marks are poorly imprinted and over-lapped, resulting in a puzzling, undecipherable mass of blurs and blots.

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Flexible distribution of heat, with pre-heating, flashing and annealing temperatures readily adjustable.

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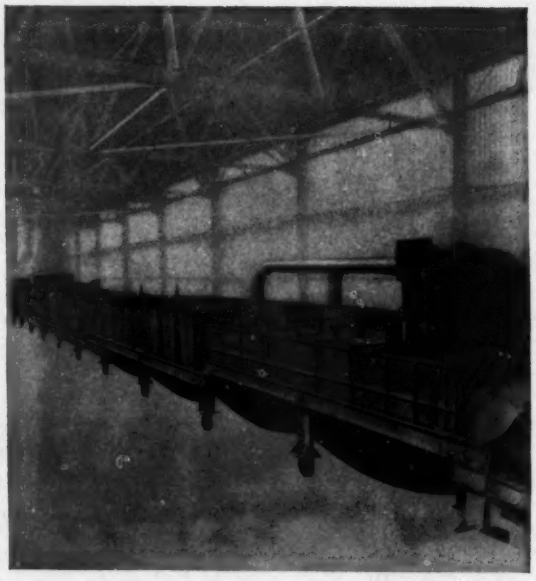

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THE GLASS INDUSTRY

VOLUME 19, NUMBER 1, JANUARY, 1938

# THE STUDY OF GLASS STRAINS AT ELEVATED TEMPERATURES

By A. J. MONACK*

The study of glass strains at elevated temperatures always offers difficulties. Qualitative or semi-quantitative measurements at room temperatures can be accomplished with ease. Polariscopes of the ordinary type are quite satisfactory. This is not the case, however, when it is important to know the intensity and distribution of strain at some temperatures above room temperature, or to know the intensity and distribution of strain while the glass is heating or cooling. Examples of such cases will come readily to mind, but one of great interest is that of glass-metal seals.

In the vacuum tube industry, where a metal must be sealed through a glass envelope in order to make electrical connection with the elements of the tube, the thermal expansions of glass and metal determine the practicability of the seal. No known metal exactly matches any known glass. Corning's Nonex glass is used with tungsten leads in a large variety of vacuum tubes.

Fig. 1 shows the thermal expansions of the glass and the metal. There are two factors to be considered in using this combination of glass and metal. Annealing the stem after pressing is a process which depends on several variables, for example, peak temperature of the furnace, rate of cooling, etc. After the tube has been made it may be important to observe the strain conditions at the temperature of operation of the tube. From Fig. 1 it can be seen that the expansion curves begin to diverge at room temperature, and do not come together again until nearly 500° C has been reached. If the tube operates at 200° C there will be a stress of considerable magnitude even in a perfectly annealed stem. The kind, amount, and distribution of stress in such a case is of great interest.

For the study of such problems as those just mentioned it was found necessary to develop a special polariscope and furnace. Since it is a useful tool for the study of many glass problems, a description seems desirable. Although the apparatus to be described was not made for extremely accurate work it could, with a few refinements, become an instrument of scientific precision.

Fig. 2 is a schematic diagram of the polariscope-furnace; Fig. 2a is a photograph.

The heating element consists of 60 feet of No. 18 chromel wire wound on the outside of a cage made of monel metal and slotted strips of lavite. This heating unit rests on the base-ring, U, and remains in place when the outer shells and polariscope tubes are removed. The element has a cold resistance of 24.4 ohms and is used with 220 volts A.C. The furnace shell consists of three concentric aluminum cylinders, D, E, and F, 6, 7½, and 8 inches in diameter, respectively, and approximately 22 inches in height. These rest in circular grooves in the base-ring, U. At the top is another ring, and on this rests a cover which serves as a plug for the top opening. A thermocouple tube, R, passes through the three shells, and is perpendicular to the line of sight through the tubes G and V.

The furnace and polariscope are carried on four legs, N, furnished with rubber casters, S. This arrangement permits easy movement of the instrument. Two of the legs have locking brakes (aluminum cylinders which bear on the rubber tires of the casters) to prevent accidental movements.

The cup M is used to hold the specimen under examination. A plug of Sil-O-Cel or any other easily shaped material is placed in the cup and the specimen is carried on or partly in the plug. Any convenient arrangement is used here, much depending on the shape and size of the glass. The cup is fastened to the upper end of a special pedestal, T. This is a hollow steel rod, threaded on the outside, which serves as a rack. A pinion, P, permits the specimen to be raised into position in the furnace. By means of the handle, Q, the specimen can be rotated in the furnace. The helical thread on the pedestal could, of course, be replaced by a circular rack.

The sighting tubes V and G are of 2-inch diameter

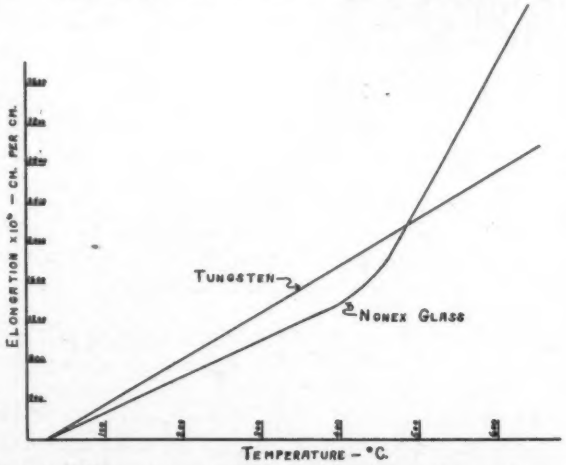


**Fig. 1. Thermal expansions of tungsten and Nonex glass.**

*Western Electric Co., Inc., Vacuum Tube Shop, New York City.

aluminum. These tubes penetrate the three cylinders D, E, and F, and are flush with the inner wall of D.

Tube V with its attachments is the polarizer. B is the light source (a 50 candlepower automobile headlight bulb, operating on 6 volts), which is placed at the focus of a double convex lens. The emergent light, which is essentially parallel, strikes the black glass plate A (placed with an angle of incidence of 56.5°) and is reflected (polarized parallel to the plate) into the tube V. The end of the bulb B was etched in hydrofluoric acid in order to mask the filament. A more detailed drawing of the polarizer is given in Fig. 3.

Since the angle at which a specimen must be held for examination between crossed nicols is 45° to the planes of polarization of the nicols, this would have required insertion of the specimen at this awkward angle instead of the vertical position desired. To avoid this the polarizing plate was rotated 45° about the point where the center line of the tubes cut the plate. By swinging the plate in one direction the green field (colors higher than first-order red) is obtained with tension in the glass; in the other direction the yellow field (colors lower than first-order red) is obtained.

Tube G with its attachments is the analyzer. The polarized light, after passing through the specimen strikes a quartz retardation plate, J (565 millimicrons), and then the nicol prism, I, with its plane of polarization turned 90° to that of the polarizer. Plate H is merely a glass disk used to protect the nicol. Figure 4 gives details of the analyzer.

There was one important problem to be solved in connection with the analyzer. Since the furnace was to be operated at temperatures near 600° C the matter of cooling the nicol prism had to be considered. Aluminum is an excellent heat conductor. Recourse was had to two methods of heat stoppage. The metal path was broken (except for bolts) by insertion of a ring of machined fiber, L. This aided materially, but was not enough. The section K was then inserted. Since this section contains about eight cooling fins the heat conduction past this member is small. By painting K and the eyepiece black, radiation was increased. As a result of these measures the eyepiece does not reach a temperature greater than about 40-50° C.

Temperature in the furnace is controlled by means of a rheostat in series with the winding. An ammeter permits settings to be duplicated. Slightly better control could be obtained by using an auto-transformer; and a program controller of the proper type would offer distinct advantage.

Recent developments in the field of polarizing film make possible a slightly simplified design. If ordinary black and white strain patterns are required polarizing disks of considerable size could be used. If, however, a color pattern is desired the field of view is somewhat limited by the size of the retardation plate. If a large disk is used for the polarizer a smaller disk with a small retardation plate can form the analyzer, provided the eye can be placed very near the analyzer. There is always a practical limit, however, to the size of opening that can be placed in the furnace walls. With a furnace operating at 600° C the amount of heat radiated through a large opening would probably be enough to exceed the safe temperature of the polarizing film (120° C). In any case it would be imperative to use fiber rings or sections and cooling fins.

The important dimensions of the polariscope-furnace may be of interest. The total height is about 70 inches; the distance from the floor to the eyepiece is about 52 inches. The furnace section is 25 inches in length. The length of each sighting tube (including eyepiece and polariscope) is about 19 inches.

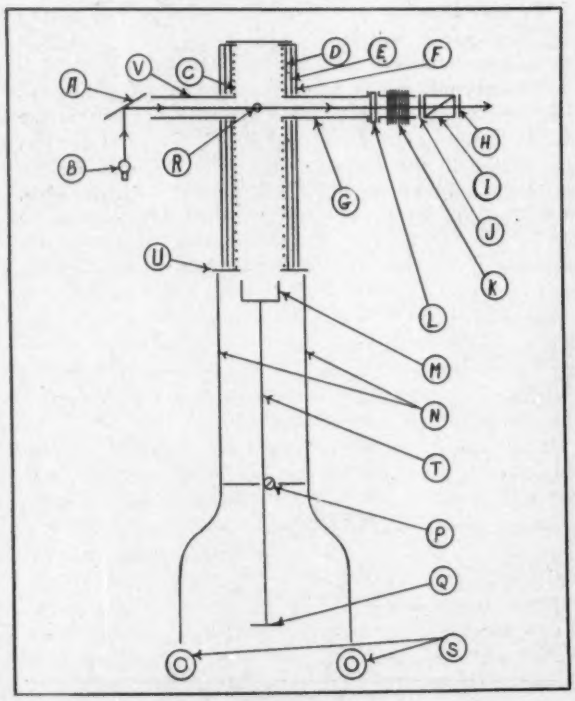


Fig. 2. Schematic drawing of the polariscope-furnace.

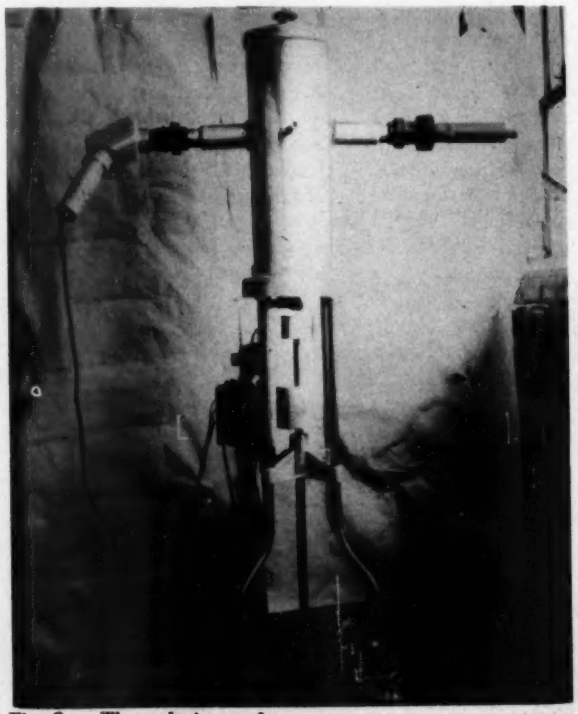

Fig. 2a. The polariscope-furnace.

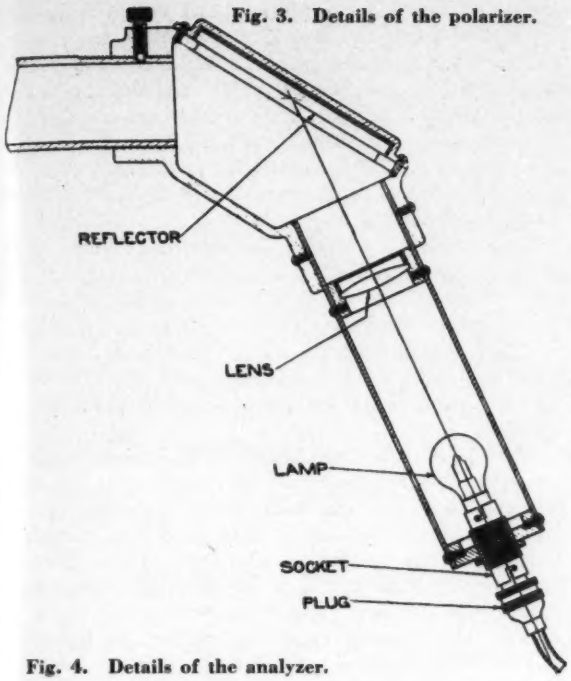


**Fig. 3. Details of the polarizer.**

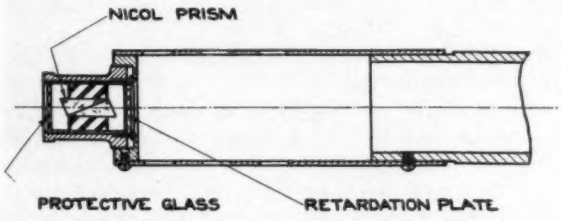


**Fig. 4. Details of the analyzer.**

This instrument has been extremely useful for developing annealing schedules. The temperature at which all strain disappears can be found with no difficulty. If the specimen is then cooled slowly (that is, with little or no temperature gradient in the glass) to the point of apparent rigidity rapid cooling may follow. By holding the specimen at the lowest temperature which permits stress release the annealing time is greatly shortened. The polariscope-furnace is a most convenient means for determining the time required for stress release at any temperature, and is valuable, in fact, wherever the intensity and distribution of strain must be observed at elevated temperatures.

*Acknowledgement:* The author acknowledges with pleasure the assistance of V. H. Van Sant and A. E. Winey, who designed the mechanical details of the polariscope-furnace.

## G.C.A. TO START MILK RADIO CAMPAIGN

To boost the retail sale of bottled milk, the Glass Container Association is launching an ambitious radio program, to start at 1:30 P. M. Sunday, Jan. 9, thereafter weekly, for at least a test period of 13 weeks and perhaps for a year. GCA's program will be heard over the N. B. C. Blue network in New York, Chicago, Philadelphia, Baltimore, Cleveland and Detroit.

The Association's Advertising Manager, Frank Carson, has been looking for some time for a program to carry the milk bottle message. Final choice was the "There Was a Woman" series, thoroughly tested since last summer as a sustaining program from N. B. C.'s Chicago studios. Each program dramatizes the story of the woman behind the men in American history. Direction will be in the hands of Fred Uttal, with a cast headed by Ed Jerome, who has established an enviable record as a radio actor. The orchestra will be under the direction of Graham Harris.

## PENN. STATE HAS 11 EXTENSION CLASSES

The School of Mineral Industries of the Pennsylvania State College is offering extension training for the first time in Pennsylvania on the basis of a three-year articulated curriculum. The first year is preparatory; the second covers the geology, geography, mineralogy, winning and preparation of all ceramic materials; the third year will be optional terminal courses in refractories, enameling, glass, heavy clay products and whiteware.

This year eleven classes were organized in nine class centers in nine counties with eleven teachers and an enrollment of 256 men:

The class at Derry was organized in cooperation with the Westinghouse Electric & Manufacturing Co. with R. A. Snyder and William Peterson as teachers.

The class at Washington was organized in cooperation with Hazel-Atlas Glass Co., Tygart Valley Glass Co., Findlay Clay Products Co., and B. F. Drakenfeld Co. with Paul Knestrick as teacher.

Cooperating in the New Castle class are the Shenango Pottery Co., Universal Sanitary Co., and the New Castle Refractories Co., with W. S. Emley and French Johnson as instructors.

Cooperating in the Kittatining class are Pittsburgh Plate Glass Co., Continental Clay Products Co., and Kittatining Brick and Fire Clay Co., with Russell A. Strang as teacher.

Owens-Illinois Glass Co. cooperated in organizing the Clarion class, taught by D. Labino.

The class at Summerville was organized in cooperation with the Hanley Co., with Gail R. Truman as teacher.

Harbison-Walker Refractories Co. and North American Refractories Co. cooperated in the organization of the Mount Union class which Daniel Kocher teaches.

The class at Lock Haven was organized in cooperation with Harbison-Walker, General Refractories Co., and the North American Refractories Co., with J. H. Ammerman as teacher.

Two of the centers—those at Derry and Clarion—are so-called "captive" classes, while the other seven classes are organized under public supervision and control in cooperation with the State Department of Public Instruction and local school districts. Under the "captive" class arrangement, the men enrolled in the classes pay a certain stipulated sum adequate to take care of the teaching and other expense of the classes. Classes organized under public supervision and control have the teaching expense met by allocations of federal and state money available for vocational teaching.

Textbooks for all the courses are prepared by the Division of Mineral Industries Extension and are made available to the students at less than actual cost. In the classes under public supervision and control, the only expense to the students is the purchase of his text material, plus an incidental fee of 50 cents to cover a slight expense of registration forms, transportation charges on books and the cost of issuing certificates and diplomas.

As the demand for classes in centers other than those already organized is made, Penn State will attempt to meet these demands insofar as its appropriation permits.

## THE NEW YORK CHEMICAL SHOW

The 16th Exposition of Chemical Industries was held in New York City during the week of Dec. 6, and featured many items of interest to the glass field. The following review of the "show" must necessarily include only the high spots of the various exhibits that directly concerned the glass industry.

*Refractories*—For those interested in the latest developments in the field of refractories the Carborundum booth displayed samples of their "Mullfrax" S; "Alfrax"; and the recently developed "Monofrax." The "Mullfrax" S brick is a converted Cyanite type block possessing a low thermal conductivity and a high chemical stability. This material is suitable for use in the upper structure of glass furnaces, for example, as tuckstones, port bottoms and the like. The "Alfrax" block is composed of fused alumina and finds use where a high thermal conductivity material is desirable. Three different types of "Monofrax" brick* were shown. Being an electrically melted and cast material, the bricks are extremely dense and are claimed to be highly resistant to both slags and glasses. Their thermal conductivity is higher than the usual fireclay block.

Insulating brick and insulating refractories were well covered by the exhibits of the Johns-Manville Co. and the Quigley Co. In the booth of the former samples of their various insulating materials and data concerning the performance and properties of their Superex blocks, Sil-O-Cel brick and concrete, and JM-20 brick were available. At the Quigley booth information concerning their Insulbrix, Insulblox, Insulag, Insulcrete and Hytempite materials was available. In addition displays of their materials and the method of use were shown.

*Measuring Instruments*—After viewing the various exhibits of measuring instruments that are used in the glass industry one could not help being impressed by the progress the various instrument companies have made in the past ten years. Not so many years ago the glass man had to be content with an indicating pyrometer and a truthful tank-teaser. Today, however, the "show" had on display pyrometers that both record and control from one to six temperatures, draft recorders and controllers and complete combustion control instruments.

For example, the Bailey Meter Co. exhibit featured a complete combustion control panel that automatically maintains the desired furnace temperature, the most economical fuel-air ratio and the desired furnace draft. Similar equipment was also on display by the Bristol Co., Brown Instrument Co., Foxboro and by the Leeds and Northrup Co.

Turning to the measurement and control of liquids and gaseous fuels the American Meter exhibit featured their new Round Indicating Flow Meter which because of its simplicity of operation is finding considerable use where the measurement and control of oil, gas, steam or air is necessary. Other equipment shown included orifices, flow meters, liquid level recorders and controllers and rate-volume control instruments.

At the Pittsburgh Equitable Meter booth a varied line of disc, current and piston type meters for measuring gas, water and oil were displayed.

*Scales*—One of the most interesting exhibits was at the booth of the Toledo Scale Co. where one of the newly developed Toledo Chronoflo machines was in operation. By means of the Chronoflo it is possible to weigh materials and totalize their amount as they are passing along a conveyor belt. Possible uses of the Chronoflo in the glass industry are the weighing of materials into and out of storage bins, the weighing of the batch materials, the weighing of the batch as it is fed to the furnace or to the batch bins and the automatic weighing of cullet from the wash chest or storage.

At the Fairbanks, Morse Co. booth a working model of a Fairbanks Conveyor scale which also weighs material while it is in transit was shown. In addition a Printomatic Scale which gives a printed record of all weighing operations made on the scale was displayed. The Printomatic Scale is useful in cases where a check on the operation of the batch weighing plant is required.

*Material Handling, etc.*—In the material handling and conveying displays there were many interesting exhibits. Vibration type conveyors were shown in actual operation by both the Syntron Co. and the Jeffrey Manufacturing Co. The Syntron Co. also featured their electromagnetic vibrators for use on hoppers, bins and chutes.

The exhibit of the Link-Belt Co., was noteworthy as it showed nearly every conceivable method of handling and conveying material. Many of the methods and combinations of those shown are extensively used by the glass industry.

Methods of controlling the speed of lehr belts, stackers, bottle conveyors and the like were well covered by the exhibits of the Link-Belt Co., in which the P.I.V. Variable Speed Transmission Equipment was featured, the Vari-Speed Motor drives and Vari-speed motor pulleys of the Reeves Pulley Co.; the varied line of speed reducers and powered gears of the Foote Bros. Gear and Machinery Corp., and the Motor Reducers and Herringbone Reducers shown by the Philadelphia Gear Works.

A full line of lift trucks suitable for moving packed ware in and about the glass packing room and warehouses was shown by both the Barrett-Cravens Co. and the Yale and Towne Co.

*Glass Exhibitors*—Judging from the crowds viewing the booth of the Owens-Illinois Glass Co. and the two Corning Glass Works booths, the chemical industries are becoming extremely glass conscious. At the Owens exhibit both fiber glass and glass block were featured, the former receiving by far the most interest by the Chemical Show visitors. This was probably due to the fact that the actual weaving of the glass fibres was shown along with numerous examples of what could be accomplished with the material.

At one of the Corning Glass Works booths (featuring glass block in the construction) industrial glass equipment for heat exchangers, piping, nuts and bolts and other forms of anti-corrosive glass equipment was featured. The other Corning booth was devoted to a display of fibrous glass for filters, insulation, etc.

*See The Glass Industry, page 363, Nov. 1937.

## NOVEMBER WINDOW GLASS PRODUCTION

Window glass production was 1,095,267 boxes during the month of November, which represents 67.5 per cent of industry capacity. The total production for 11 months of 1937 amounted to 12,625,211 boxes, which represents 70.7 per cent of industry capacity.

**Aerial view of part of the River Rouge plant of the Ford Motor Co., showing the glass plant in the foreground.**

# HOW FORD MAKES ITS GLASS: II

**By F. G. SCHWALBE**
**Toledo Engineering Co.**

**This, the second of a series of three articles on the production of glass at the Ford Motor Co. plant, deals with the rolling, grinding and polishing operations. The first article, which appeared in December, described batch handling, mixing and melting.**

From the end of the melting furnace at the Ford Glass Plant the glass flows over a trough-shaped clay spout approximately 53 inches wide. Two large refractory gates, one for a stand-by, control or shut off the flow of glass to the rolling machine. The temperature of the glass delivered to the rolling machine is held at approximately 2250°F., this temperature being maintained by control of the furnace pressure and the fuel input. Extending the entire width of the spout, a row of small jet burners play on the under-side of the tip to prevent glass contamination.

The Ford rolling machine, as shown in Fig. 1, incorporates two pairs of rolls, the top rolls being adjustable to permit control of the sheet thickness. All rolls are made of cast iron and are water cooled to maintain the proper working temperatures. Between the two pairs of rolls is located a horizontal flat, cast-iron plate. This plate has small perforations through which compressed air is forced, causing the glass sheet to rise and virtually float in the air when passing from the first to the second set of rolls.

In the first set of rolls, the glass temperature decreases about 750°F. After the passage through the second set of rolls the temperature has decreased another 400 degrees and the glass enters the lehr at a temperature of 1100°F. A 40-horsepower, direct-current motor drives the rolling machine, together with the conveying rollers which carry the sheet through the annealing lehr. Located directly over the rolling machine is a 15-ton traveling crane for machine removal. The rolling machine is mounted on wheels so that it may be moved sideways, thus giving access to the glass-feeding spout when replacement or repairs are necessary.

Glass is rolled in a continuous sheet at speeds up to 200 inches per minute. During a recent production run a continuous sheet of glass over 500 miles in length was rolled, without an interruption in the operation of the machine. The sheet, as it leaves the rolling machine, has a width of 54 inches, but as the sheet passes through the annealing lehr its width decreases to approximately 50½ inches at the discharge end.

### Annealing lehr

The Ford annealing lehr is elevated so that the moving glass sheet is located 12½ feet above the factory floor. The lehr is built of refractory and insulating material, entirely housed in a steel shell. The glass is carried on 6-inch steel rollers, spaced 10 to 20 inches on centers. Each roller is mounted in bearings located outside the lehr and, for cooling, a small jet of compressed air is directed into one end of each lehr roll.

Keyed to the end of each roll shaft is a worm wheel which meshes with a worm mounted on a shaft running the length of the lehr. This shaft is driven from the same motor which furnishes power to the rolling machine.

The lehr has a length of 475 feet, including a 50-foot open section, as shown diagrammatically in Fig. 2. It will be noted that the electric heating elements are located above and below the glass. Nine potentiometer pyrometer controllers regulate the current input to the heating elements and thus maintain the desired temperatures, each potentiometer controlling the temperature in a 30-foot length of lehr. Temperature indications are taken two inches below the glass by means of a manually operated, millivoltmeter pyrometer.

Photos Courtesy of the Ford Motor Co.

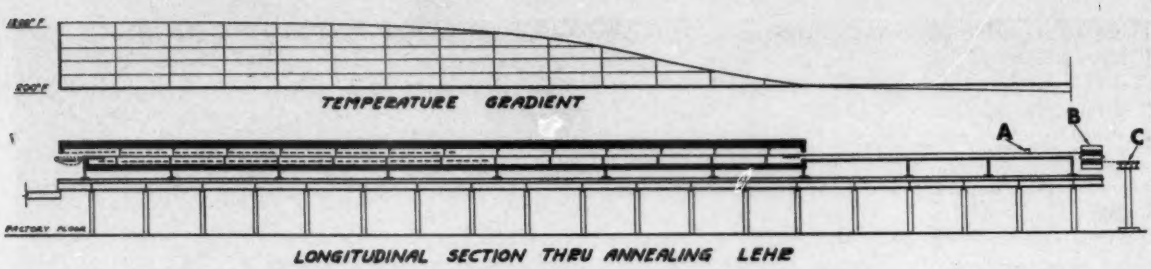


**Fig. 1. Diagram showing longitudinal section through lehr and temperature gradient. A. Edge trimming and sheet cutoff. B. Rough sheet turnover. C. Lowering mechanism.**

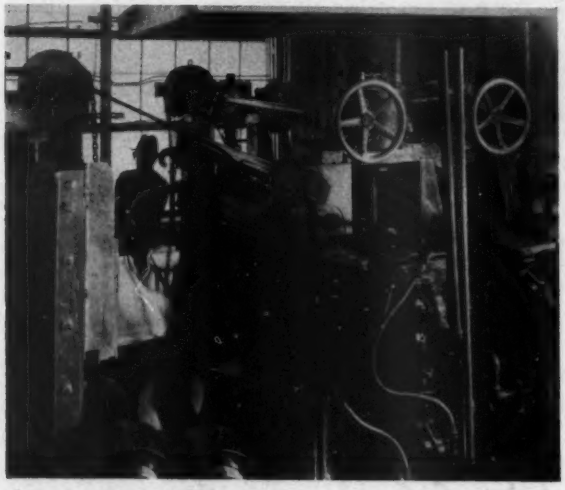

**Fig. 2. Sheet leaving Ford continuous rolling machine and entering lehr at left.**

### Sheet trimming and cutting

The continuous glass sheet leaving the Ford electrically heated annealing lehr is cut into 140-inch lengths to fit the grinding and polishing tables. Fig. 3 shows the glass being cut into lengths and edge-trimmed to a 46-inch width. The edges of the moving sheet are trimmed by two stationary cutters mounted at each edge of the sheet, one cutter being set 1½ inches in from the edge of the sheet and the other approximately ¾ inch. One man on each side removes the trimmed edge as the sheet moves along.The glass from the lehr is 0.176 in. thick.

### Sheet turnover

On account of its contact with the conveying rollers, the under side of the glass sheet leaving the annealing lehr is found to be hardest and, for most satisfactory grinding operation, the hardest face should be ground first. Therefore, it is necessary to turn the sheet over as it leaves the lehr, so that it will have the hard face uppermost and be ready for placing on the grinding tables. An automatic turnover device of Ford design receives the glass at the end of the lehr, immediately after the cutting and trimming operations. The operation of the turnover device is as follows:

A sheet of glass leaving the lehr rollers enters a double set of rollers until a stop is reached. Located approximately 12 inches below this set of rollers is a second set which already is carrying the preceding sheet of glass and when a sheet of glass enters the top rollers, the lower sheet is discharged at the lower level. Both the upper and lower sets of rollers are mounted in a framework on a common trunnion which permits the two sets of rollers to be turned over bodily. Thus each sheet is turned over with the roller framework and is discharged from the lower set of rollers with the harder face uppermost. The entire operation of this device is automatically controlled by limit switches which are actuated by the incoming and outgoing sheets. The glass leaving the turnover is 11½ feet above the factory floor and ready to be lowered to the grinding machine level.

### Lowering mechanism

Upon leaving the turnover device, the glass proceeds on a series of conveyor rollers until it makes contact with a limit switch that starts the lowering mechanism. This device is like an enormous common table fork, between the straight prongs of which are rollers supported at one end only. The tops of the rollers are slightly higher than the prongs on the fork, so the sheet passes over the top of the fork prongs until it reaches the limit switch. The rollers are hinged at their supporting ends and now swing downward, leaving the sheet resting entirely on the prongs of the fork. When the rollers have cleared the sheet the fork is lowered, carrying the sheet to the grinding level. Here the fork prongs pass between another set of power-driven rollers which catch the sheet as the fork prongs pass through. The sheet is now conveyed to a point where it is ready to be picked up and placed on the grinding table.

### Grinding and polishing

The Ford grinding equipment is arranged in two adjacent lines with an integral framework, each grinding line

**Fig. 3. Cutting sheet into 140-inch lengths. Edge trimming cutters on cross-bar at extreme right.**

having an overall length of approximately 330 feet. Fig. 4 shows the two adjacent grinding lines, and two similar lines of polishing machines are located parallel to them.

To provide foundations for a structure of this kind it was necessary to carry the loads to bed rock, because the permissible soil bearing-pressure is very low. Fig. 5 shows the longitudinal beams forming the backbone of the lines, the load from these beams being carried to 4½-foot concrete piers spaced 40 feet on centers. Each pier goes to bed rock, which lies at a depth of approximately 110 feet below the factory floor. Massive concrete beams tie one pier to another.

Each line carries 25 tables weighing 11½ tons each and each table accommodates two sheets of glass, each 47 inches wide and 140 inches long. Each grinding line has 30 heads, operated by 40-horsepower motors that transmit their power through V-belt drives and worm gears. Each grinding head carries a cast-iron lap to which sand and water are fed, the first lap receiving the coarser sand, while the succeeding laps receive successively finer grades of sand.

During the grinding operation it is desirable that a predetermined pressure on the glass be maintained, but this is complicated by the fact that the weights of the laps do not remain constant. For instance, the first lap receives the coarsest sand and wears most rapidly. To compensate for these changes in the weights of the laps an ingenious, air-pressure, compensating device, designed by Ford engineers, permits a uniform predetermined pressure to be maintained on the glass. In the event of failure of the mechanism propelling the tables, the pressure compensating device causes each grinding and polishing head to be instantly lifted clear of the glass. Fig. 6 shows the upper walk way along the polishing line with the operating motors and the air-pressure compensating devices.

Each polishing line also carries 25 tables and is equipped with 50 heads driven through V-belts by 40-horsepower motors. Each polishing head is furnished with eleven felt discs, each having a diameter of approximately 18 inches.

Tables are propelled under the grinding and polishing heads at a rate of 150 inches per minute. A 200-horsepower motor propels each line of 25 tables through two pinions which engage a double rack secured to the under side of each table. Tables on each of the two grinding and polishing lines traverse its length very much as a planer table slides along its ways. A very ingenious system provides lubrication of the ways, insuring a measured amount of oil to each unit length of track.

**Glass and table cycles**

From the time it reaches the grinding floor level until it has been completely ground and polished on both sides, the glass follows a path that has been planned for the utilization of mechanical handling exclusively. This path, together with the location of the various pieces of special handling equipment, is shown diagrammatically in Fig. 7. The successive positions of the glass sheet are designated 1, 2, . . . 16. To simplify the diagram only one sheet of glass is shown on each table, but it must be remembered that each table actually carries two 47 x 140 inch sheets.

If the grinding and polishing lines are numbered 1, 2, 3 and 4, in order of their location with respect to the lehr, it will be noted that the glass passes through No. 1 (grinding) line, then is transferred to and passes through line No. 3 (polishing). These passes completely finish one face of the sheet, which is then transferred to No. 2 (grinding) line. During this transfer the sheet is turned over and placed on another table. When the pass through No. 2 is completed the glass is again transferred to No.

**Fig. 5. Construction view of grinding line foundation showing heavy longitudinal beams on concrete piers.**

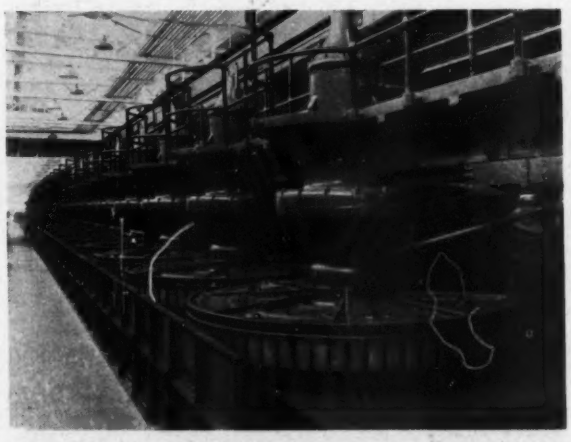

**Fig. 4. Looking down the first grinding line, showing cast-iron grinding laps. Pressure regulators in conical housings at tops of spindles.**

**Fig. 6. Walkway above and between the polishing lines, showing driving motors and pressure regulator housings at either side.**

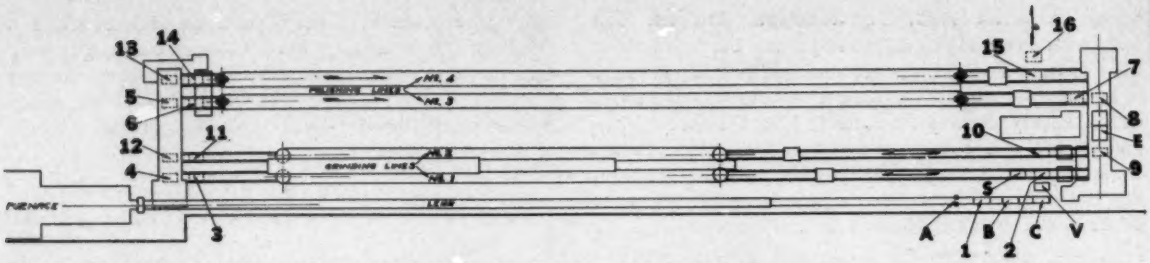


**Fig. 7. Diagrammatic plan of furnace, lehr, grinding lines and polishing lines. Nos. 1 to 16 indicate successive positions of the glass sheet. A. Edge trimming and sheet cutoff. B. Rough sheet turnover. C. Lowering mechanism. V. Vacuum-type handling crane. S. Squeegee. E. Special "book-type" sheet transfer.**

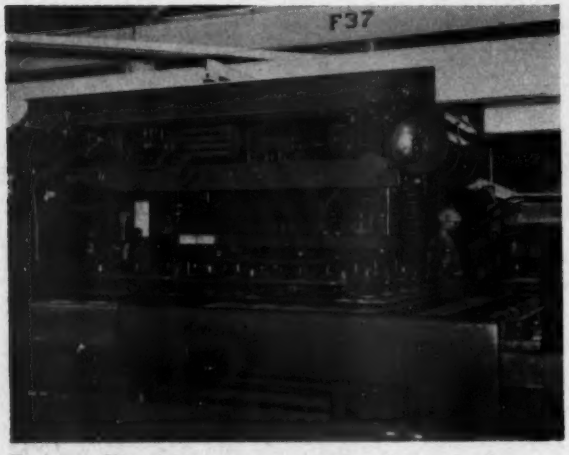


**Fig. 8. Vacuum-type crane transporting two sheets to grinding table.**

**Fig. 9. Squeegee cranes setting the sheets in the plaster at the heads of the grinding lines. Plaster is removed from the surface of the glass before it passes under the grinding heads.**

4 (polishing) line and, at the end of this passage, is completely ground and polished, ready for washing, inspection and cutting. During these operations it is apparent that the glass makes two complete circuits of the grinding and polishing department.

The path of the tables is simpler. At the head of the grinding lines the first table on No. 1 line is empty and ready to receive the rough sheets. The table at the head of No. 2 line carries a sheet with one face finished and the rough face uppermost. These two tables pass through the grinding lines side by side and are then transferred to the polishing lines Nos. 3 and 4, respectively. Again side by side, the two tables pass through the polishing lines and at the end the finished sheet is removed from the second table (No. 4 line). At the transfer point, therefore, the first table now carries a sheet with one face finished, and the second is empty. During the transfer the half-finished sheet is lifted, turned over and placed on the empty table immediately behind, so that the two tables arrive at the heads of their respective grinding lines in the same state as at the beginning of the cycle.

### Finishing and handling operations

The first handling operations in the grinding process are the removal of the unfinished sheet from the roller table, to which it has been brought from the lehr level by the lowering mechanism, and its location on the grinding table. The vacuum-type handling crane, illustrated in Fig. 8, performs this service, setting the sheet in the thin slurry of plaster of paris which has just been spread on the table. The weight of the sheet is not sufficient, however, to set the sheet firmly, so the "squeegee" crane, shown in Fig. 9, is used to press the sheet down into position and force all air from between the sheet and the table surface.

**Fig. 10. Loosening the sheets from the plaster bed at the end of the first polishing line (No. 3 line Fig. 7).**

The sheet now passes under the thirty grinding heads and is washed and inspected at the end of the line. Should any of the glass have been broken or dislodged, the necessary repairs are made here. Fig. 10 shows such repair operations being done in what is commonly called "the middle grounds." The table is now transferred from the first grinding to the first polishing line and Fig. 11 illustrates the table transfer mechanism at this point. After passing under the 50 polishing heads, the table reaches the other transfer, along which it passes to a position beneath a unique handling device of Ford design.

As mentioned, the handling operation at this point is to lift the half-finished sheet from its original position on the first table, turn it over, and deposit it on the empty table immediately behind. As shown in Fig. 12, the mechanism includes two sections, fitted with vacuum cups and hinged together so that they open and close somewhat like a huge book. The operator, controlling the operation of the device from a push-button station, causes the "book" to descend in the open position until the vacuum cups of one section are in contact with the plate. The vacuum is then connected to this section and the "book" is raised, carrying the sheet and closing as it rises. At the closed position, Fig. 13, the vacuum cups of both sections are in contact with the sheet and at this point the vacuum is reversed from one section to the other. Then as the "book" again descends, opening as it goes, the sheet is carried by the second section, deposited on the empty table, and released when the vacuum is cut off.

The setting, grinding and polishing operations on the second face of the sheet are a duplication of the first, the table passing this time under the second lines of grinding and polishing heads. At point 15, Fig. 7, the finished, ground and polished sheet is removed from the table and, from point 16, is conveyed to the continuous inspection and cutting department. This department will be described in the next article of this series.

Before grinding and polishing the glass has a thickness of 0.176 inch and it is 0.115 inch thick after grinding and polishing. To accomplish this result many tons of sand and approximately 7,200,000 gallons of water at 100°F. are required each 24 hours. The total weight of material ground from the sheets amounts to 51 tons of glass per day and the total waste materials resulting from the grinding and polishing operation vary from 500 to 900 tons per day. The handling and disposal of this enormous amount of waste, the recovery of the water and the conservation of the heat is handled with typical Ford efficiency by means of a system of settling tanks and continuous filters.

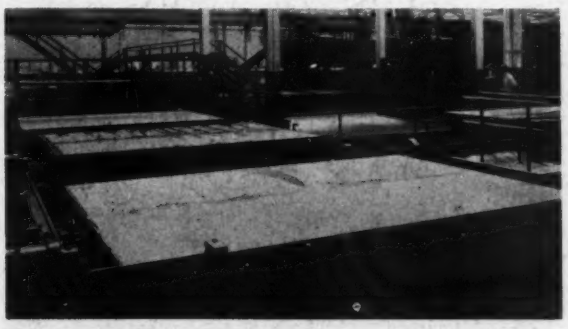

**Fig. 11. Table transfer from end of grinding lines to beginning of polishing lines. Polishing heads appear in the background at upper right.**

### Laboratory control and measurements

The Ford glass plant laboratory, shown on the front cover, is well equipped and is manned by an experienced staff of technical men. It is responsible for the exact scientific control of the vast amounts of raw materials used in the Ford glass plant and conducts tests continually as a check on the quality of the product. The internal strain in the finished product is watched very carefully and the condition of the glass at various points in the production line is also checked.

After glass has passed the polishing line, even a layman can recognize differences in the quality of the finished plate, but this is not true of the grinding operation. Only years of experience enable one skilled in the art to

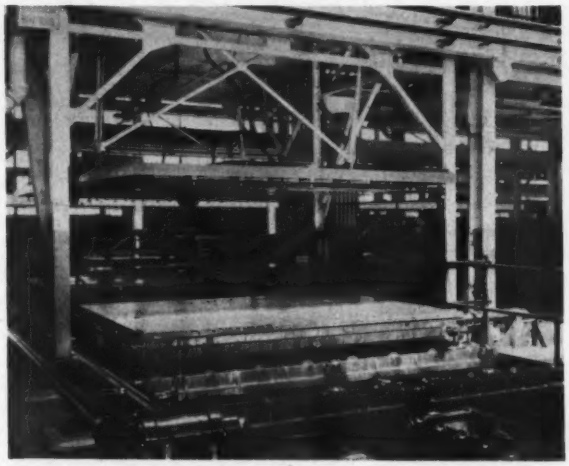

**Fig. 12. Book-type sheet transfer in open position. The device has picked the half-finished sheets from the further table and is about to place them on the empty table in the foreground.**

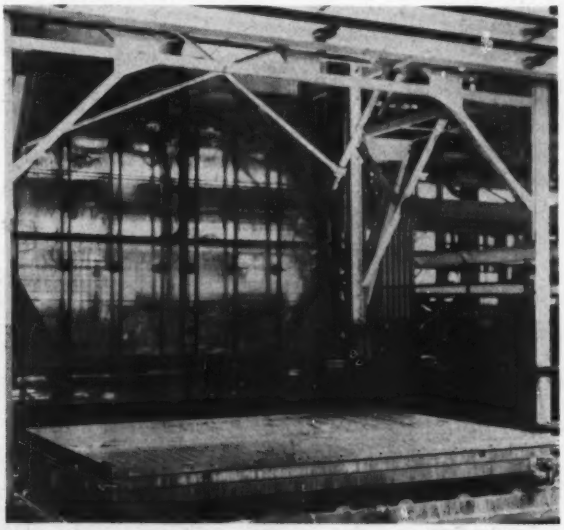

**Fig. 13. Book-type sheet transfer in closed position. The vacuum cups of both sections are in contact with the sheets and a reversal of the vacuum transfers the sheets from one section to the other. As the device opens and descends the sheets will be carried forward to the position shown in Fig. 12 and deposited on the empty table.**

ascertain by feel and examination the result of a given grinding operation. Such methods, of course, are not in line with the Ford Motor Co. practice of scientific control and the elimination of the human element for accuracy in inspection measurements. Therefore, at the Ford glass plant the fineness of the grinding operation is tested by traversing the surface with a little instrument which actually measures the heights and depths of hills and valleys.

This small device, about 3 inches long, 2 inches high and an inch wide, carries on its under side three hardened steel points, arranged in triangular relationship, and a diamond-studded point. The diamond point is attached to a movable lever which permits the diamond to follow the slight indentations left by the grinding operation. The magnitude of these indentations, averaging about 90 millionths of an inch, is amplified and indicated directly by the deflection of a needle traversing a scale.

## PHYSICO-CHEMICAL BASES OF GLASS

*The physico-chemical bases of the glass industry* (*Les Bases Physico-Chimiques de l'industrie du verre*) by Pierre Gilard and Leon Dubrul. Paris, Dunod, 1937, p. 221, Figures 4 and 5.

This is a good little book, but it is not strictly what its title implies. Only a small portion of the work deals with physical chemistry as ordinarily understood, and even if we translate "physico-chimiques" very broadly as "physics and chemistry," we should be forced at times to stretch "physics" to include "mechanics." Having then broadened the field considerably, we find that many parts are necessarily dealt with very cursorily.

In the preface we are assured that this is not a treatise on glass making, but it comes within sight of being so. It does not describe workshop equipment, as the older textbooks always did, but it attempts to sketch the scientific background and foundations of the art of glass making. In this it is not unsuccessful, though the foundations are not laid very deep, and the background is largely atmospheric haze.

Gilard's concept of the glassy state is apparently still limited by a rather imperfect grasp of the crystalline state, and although he has now added a footnote to admit that crystals of the cubic system are not anisotropic (P. 13), what is really needed is not an amendment of this sort, but a radical revision of his whole point of view. The same thing is true, in a minor degree perhaps, of his treatment (P. 23) of the origin and effect of stresses left in glassware by the annealing process or its absence.

After an introductory chapter on these general themes, we get one on viscosity, which is good physics, and then one on raw materials, which is a difficult subject anyway, and must necessarily be a mixture of chemistry, economics, and a vast amount of empirical information.

Chapter IV comes as near being physical chemistry as any of them. It deals with reactions and reaction rates in the melt. On the whole, it leaves the impression that physical chemistry has not very successfully been applied to glass making up to date. Chapter V, naturally, deals with crystalline equilibrium diagrams for certain technical silicates.

In Chapter VI, page 121, in dealing with defects in glass, we are assured that stones are necessarily displeasing to the eye, though aventurines are full of stones; that stones are necessarily surrounded by dangerous stresses, though polariscopic examination shows that many show no stresses at all, and among those that do, many give excellent service for a generation or more and the glass finally fails for some other reason. We are also told that all stones are white, while everyone knows that they can be black, green, grey, and other colors. The photoelastic constant is given as substantially equal for all glasses not containing much lead, but it does in fact depart substantially from the usual variety with other lead-free glasses.

Taken by and large, this is a good little text for students in college, particularly in their first year. It is too technical for the workshops, and it is not extensive enough, or precise enough, for advanced students. Its inaccuracies, however, are probably less than in most textbooks in the English language.—F.W.P.

## A. C. S. PLANS FOR 40th MEETING

Plans for the 40th annual meeting of the American Ceramic Society in colorful New Orleans, the week of March 27, are rapidly being crystallized. In addition to the always useful papers, arrangements are being made for a series of exhibits at the following locations:

1. National Ceramic Exhibit at Newcomb College.
2. Middle American Pottery and Terra Cotta Exhibit at Tulane University.
3. Exhibit of Indian and Southern Pottery and Terra Cotta at Cabildo Museum.
4. Exhibit of Chinese and other porcelains at the studio of Mrs. Martha G. Westfeldt.
5. Geological Surveys will have an exhibit of Ceramic Materials and Products.
6. Arrangements for commercial exhibits can be made through Sam Fowlkes, Jr., Hotel Roosevelt, New Orleans.

In addition to the address by President Robert B. Sosman and the Orton Memorial Address by Herbert A. Wheeler, the Society's first president, the following papers are of particular interest to glassmen:

**Glass as a Textile Material and Some of Its Applications (Moving Film),** by Games Slayter and John H. Thomas.

**Relative Solubility of Glass in Acid Solutions as Indicated by Dye Absorption,** by E. H. Hamilton and A. N. Finn.

**A Numerical Evaluation of the Constant in the Gladstone and Dale Equation,** by A. N. Finn.

**Some Linear Relations Between Composition and Density of Binary Glass,** by J. C. Young and A. N. Finn.

**Structural Glass,** by G. M. Rapp.

**X-ray Diffraction Study of Soda-Boric Oxide Glass,** by B. E. Warren.

**The Law of Annealing of Glass—Quantitative Treatment and Molecular Interpretation,** by N. W. Taylor.

**Viscosity and Resistivity and Their Bearing on the Nature of Glass,** by N. W. Taylor.

**Use of Models for Studying the Circulation in Glass Tanks,** by Edgar Buckingham.

**Rapid Modified Method of Analysis of Soda-Lime Glass,** by M. B. Vilensky.

Among the industrial trips are those to the salt domes and sulfur mines, to the Lone Star Cement Co., the Brookhaven Press Brick Co., the Shearwater Pottery and the Mathieson Alkali Works.

Various groups, such as Keramos and the Institute of Ceramic Engineers, will hold their special meetings. Reunions are being planned by ceramic schools. And a varied program of entertainment is scheduled, such as only "the Paris of North America" can provide.

# ABSTRACTS OF SOCIETY OF GLASS TECHNOLOGY PAPERS

No small part of the meeting of the Society of Glass Technology in celebration of its 21st year of service to the industry, in addition to the laying of the cornerstone of the new Glass Department Building at Sheffield, England, were a distinguished group of papers, whose abstracts are presented in the following columns. The ceremonies accompanying this gathering were briefly described in THE GLASS INDUSTRY for December, but a few of the interesting photographs are included in the present issue for the interest of the Society's many friends throughout the world.

The abstracts of the papers follow:

**Compositions and Properties of the Chief Types of Commercial Glasses,** by Professor Dr. G. Keppeler, Hanover, Germany.

Formerly glass manufacturers were compelled to employ glass compositions of high lime and low alkali contents, because of the expensiveness of soda ash and sodium sulphate. Wherever possible natural raw materials were utilized. With the introduction of automatic machinery in bottle and sheet glass manufacture these compositions were no longer suitable on account of their high melting temperature and great tendency to devitrification, and it was necessary to employ more alkali and less lime in the composition. This decreased the durability of the glass, which, however, was still sufficient for containers in general.

The Mylius classification of chemical resistance together with durability results obtained by the powder method, permitted the durabilities of soda-lime-silica glasses to be predicted. The conclusions agreed well with the durability results obtained by other workers for containers of different alkali contents.

**The Adherence of Aluminum to Glass and Its Technical Applications,** by Dr. Bernard Long, Glaceries de St. Gobain, Chauney & Cirey, Paris.

Under certain conditions glass surfaces were readily metallized by spraying with aluminum. The metal coating was tenaciously held by the glass. Preferably, glass to be metallized should be toughened to resist the chilling action of the blast from the spraying gun.

The reflecting power of aluminum coated glass enabled mirrors to be utilized in adverse weathering conditions, for mirrors at cross roads, and pavement lights. Hollow glass bricks coated on the inside with aluminum greatly reduced the radiation losses obtained with the untreated bricks.

Aluminum resistances on glass, in the form of strips sprayed in a zig-zag manner made efficient glass radiators, whilst floor blocks, coated with aluminum and forming a continuous electrical connection enabled heated floors to be used in offices and other rooms, the power expended being approximately 1,200 watts per 8 square meter to maintain a floor temperature of 30°.

**Physical Property—Temperature Relationships; Their Bearing on the Nature and Constitution of Glass,** by E. Seddon, B.Sc., Ph.D., University of Sheffield.

The main objects of this paper were 1, to relate the change of such physical properties of glasses as, viscosity, etc., with temperatures; 2, to co-ordinate one with the other these physical properties; 3, to draw conclusions regarding the nature of glass, using for comparison substances other than glass, such as, metals, certain of the aliphate alcohols, and water, concerning the structures of which substances something was already known.

The glasses investigated ranged from the elementary glass selenium, to fused boric oxide and silica, sodium borate and soda-silica glasses, and the complex soda-lime-silica glasses previously examined. In addition the organic glass glucose was included.

Values of e (the energy of cohesion) based on experimental data for the above glasses decreased with rising temperature from a high value to two limits according to whether high $SiO_2$ or high $B_2O_3$ contents were present. This supported conclusions drawn from X-ray diffraction photographs on the structure of glass.

Of the comparison materials, mercury, benzene and

**Foundation Block laying ceremony at Elmfield the new home of the Department of Glass Technology, Sheffield. (Geoffrey L. Pilkington is speaking.)**

**Professor W. E. S. Turner inserting in a glass lined cavity in one of the walls at Elmfield a glass casket containing records.**

**Geoffrey L. Pilkington laying the special Foundation Block of Glass, at Elmfield.**

carbon tetrachloride gave E values independent of temperature; molten metals and some salts gave an increased energy of cohesion with rising temperature. Increasing length of the carbon spirals in the alcohols could be related to increasing values of e. Water with its tetrahedral grouping $H_2O$ molecules gave supercooling in a similar manner to glasses of which the silicate type contained tetrahedral groups of Si and O ions.

Estimations of the number of particles (ions, atoms or molecules) per unit volume, could also be made from experimental data, which for glasses decreased rapidly, indicating the formation of progressively larger clusters of particles, with falling temperature. For the organic glass these clusters were relatively of much greater size. Whilst mercury showed no such tendency, water showed the effect of cluster formation but to a less extent than the glasses examined.

**Some New Views on the Nature of Glass,** by J. E. Stanworth, M.Sc.Tech., the British Thomson-Houston Co., Ltd.

On the basis of the theories of J. D. Bunce and A. G. Ward on the liquid state, an examination was made of the viscosity changes in glass at temperatures between room temperature and the founding temperature. The increase in the factor B in the equation $\zeta = Ae^{B/RT}$ as the temperature fell below the founding temperature could be simply explained by a decrease in average co-ordination number; by the co-ordination number of a molecule is meant the number of its immediate neighbors.

A study of the viscosity-temperature curves for stabilized passes simplified the problem. The difference in the form of the B-T curves for stabilized and unstabilized glasses was not due to a difference in structure but to the fact that time was necessary to reach an equilibrium value of average co-ordination. It was concluded that when the viscosity had increased sufficiently with falling temperature, further co-ordination change was impossible and B ceased to increase. In this range, a gradual "local freezing" began, which meant that the particles over a small volume ceased to be capable of relative movement. This should result in a decrease in B with further fall in temperature, and this result was actually found by W. Hänlein and M. Thomas for a silicate glass and by G. S. Parks and J. D. Reagh for a glucose glass.

**Statistical Methods in the Glass Factory,** by Professor J. A. de Artigas, D.Sc., formerly of the University of Madrid.

The application of statistics to the control of the quality of production has already been introduced in many industries, but the statistical control of the standard production and systematic methods for the improvement of the output were applied only by the statistics offices of a few of the larger industries.

In the case of a glassworks, where production was continuous, there were of necessity, variations due to the different staffs working in the different shifts. Besides these variations, it was necessary to take account of the fluctuations, more or less, and also the quality of the raw materials.

By the aid of statistical methods those variations or "irregularities" due to the manufacturing processes could be divided with a known degree of precision into different groups, and variations due to the normal random distribution appropriate to the industrial process itself separated from the remaining variations which could be imputed to various "systematic" causes.

The statistical methods employed must take account of both quantity and quality, and for each of these the work must be carried out in three sections, (a) the collection of data, (b) statistical treatment and (c) interpretation of the results.

**The Viscosity of the Soda-Silica Glasses and Its Bearing on Their Constitution,** by Eric Preston, B.Sc., Ph.D., University of Sheffield.

Employing a rotating cylinder apparatus, in which the inner and outer cylinders were of platinum, viscosities at high temperatures could be determined down to one poise. The relationship between viscosity and composition at any temperature was not a continuous one.

(*Continued on page* 28)

# THE FIRST RADIANT-TUBE DECORATING LEHR

The DeVilbiss Co., Toledo, is now operating a continuous decorating lehr, which is heated by means of manufactured gas and from which the conventional muffle has been eliminated. The new lehr, used for decorating vanity set parts, replaced a full muffle-type lehr.

The general construction of the lehr is shown in Fig. 1, which is a cutaway view of a similar lehr. The products of combustion are kept from contact with the ware by burning the gas entirely within metallic, heat-resisting tubes, known as "radiant-tube" heating elements. This form of heating has been widely and successfully used for the past three years in porcelain-enameling and heat-treating furnaces, but this installation marks the first use of radiant tubes in decorating or annealing lehrs.

There are a total of four W-shaped radiant tubes in the heat zone of the lehr, two of the tubes being located above the conveyor belt and two below. The tubes are mounted through the side walls with both ends outside. One end of each tube is securely bolted to the steel casing while the other end is free to float on its support, thus allowing for contraction and expansion.

The new lehr, with an overall length of 60 feet and a width of 6 feet, replaced a muffle-type lehr 80 feet long by 8 feet wide. The muffle-type lehr had a four-hour cycle with a fuel consumption of 2,000 cubic feet per hour; while the radiant-tube lehr has a cycle not exceeding two hours for the same type of ware and a fuel consumption of only 565 cubic feet per hour. An idea of the comparative size of the two lehrs may be gained from Fig. 2, which shows the new and old lehrs side by side before the old lehr was dismantled.

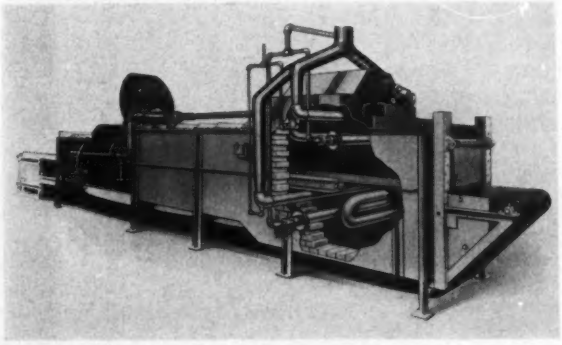

**Fig. 1. Cutaway view of lehr similar to one installed at The DeVilbiss Co., showing radiant tubes.**

### Recirculation in new lehr

Controlled recirculation has made it possible to reduce the size of the new radiant tube lehr materially, as compared with the old muffle-type lehr, and still handle the same quantity of ware with a much smaller fuel consumption.

In a muffle-type lehr, the chief agency of heat transfer is radiation, but radiant-heat transfer coefficients are ralatively low at ordinary annealing temperatures. It follows that in lehr work there are definite limitations to the rate of heat flow and, in consequence, to the temperature uniformity which can be secured by radiation alone. It has been found that the most successful way to heat metals within a temperature range from 600 to 1300° F. is by convection, which depends on the circulation of the hot gases.

In the new DeVilbiss lehr, a circulating fan is located above the tubular heating elements and circulates the heated atmosphere generated in the heat zone. The heated air is distributed below the conveyor belt under accurate control and, as it flows up through the belt and the ware loaded thereon, it produces a very rapid equalization of the temperature in all parts of the glass. A part of the heated mixture is used to control the temperature gradient accurately in the critical zone of annealing, insuring the steadily increasing temperature drop associated with the ideal annealing cycle. As a result of precise control through the critical zone and positive cooling control, it was possible to shorten the cooling zone of the new lehr materially and still bring the ware out at a comfortable handling temperature.

The principle of recirculation also helps to overcome the difficulty of varied sizes and shapes in the type of work decorated in this lehr. Vanity sets may have quite an assortment of individual pieces such as the tray, jar, dropper, atomizer, and cologne bottle. Due to the slight

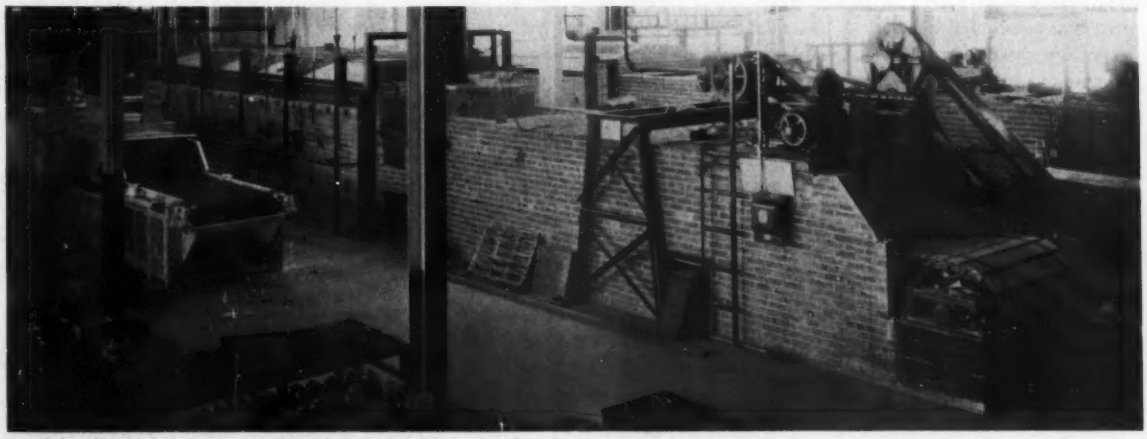

**Fig. 2. View showing comparative size of new radiant-tube lehr and old muffle-type lehr. Since this photograph was taken, the old lehr has been dismantled and the radiant tube lehr moved to the site of the old lehr.**

**Fig. 3. Charging end of radiant tube lehr. Fig. 4. Close-up view of discharge end of radiant tube lehr showing assortment of vanity sets parts.**

pressure carried within the lehr, the larger pieces are quickly exposed to the proper temperature, similarly irregular and intricately-shaped ware is well surrounded by the recirculating gases, and it is possible to reduce the lehr temperature practically to that of the ware itself. Uniformity in the heating and cooling gases obviates overheating some parts of the ware in order to make sure that all parts have been raised to the proper annealing temperature.

**Insulation and construction**

Since the temperatures at no point in the lehr, except on the surfaces of the heating tubes themselves, are much higher than the proper decorating temperature, the lehr is constructed without the use of heavy refractories required in muffle designs. Only light-weight insulating refractory is used, thus making it possible to reduce the width and decrease the necessary time and amount of heat to bring the lehr to temperature. Heat losses in the flue gases have also been reduced, since a considerably lower thermal head is used than in the muffle-type lehrs. The radiant-tube lehr can be brought up from cold to 1,000° F. operating temperature in approximately four hours, whereas it usually took two days to bring the old muffle type lehr to this temperature. It was impractical to shut the old lehr down over week-ends, because it took so long to bring it up to temperature again, but the new lehr can be shut down over weekends and easily brought to temperature for Monday morning.

The lehr casing consists of a series of rigid structural steel sections bolted together. Roof sections are removable for access to any point in the tunnel. The wire mesh belt conveyor is supported throughout on idler rollers and the drive is designed with a liberal use of ball bearings to reduce the necessary belt tension to a minimum. Automatic temperature control equipment is incorporated to make the operation of the lehr fully automatic after initial settings have been determined. The few manual controls, required for changing speeds, temperature cycles and fuel cooling rates, have been simplified to permit operation by relatively unskilled operators.

**Operation advantages**

A decided improvement in the decorative luster has been noticed since the installation of the new radiant-tube lehr, and this improvement may be traced to several sources. It is impossible for the products of combustion to escape through the metal tubes and come into contact with the work. Even if a crack should develop in one of the radiant tubes, the leakage would be inward because the tubes operate under suction. On the other hand, it is difficult to keep a refractory-type muffle impervious to combustion gases and even new muffles often have a slight amount of leakage. Another reason for the improved luster is that the controlled recirculation gives every part of each piece of glassware the same heat treatment throughout the cycle. This is especially important for ware having relatively thick and thin sections, since, without the feature of controlled recirculation, there is always the possibility of overheating the thin sections in order to bring the thick sections up to temperature in the proper time.

The recirculation principle also makes it possible to use higher belt speeds through the heating and annealing zones. In order to take advantage of this fact, the final cooling zone has been designed to permit acceleration of the cooling rate in this portion of the tunnel and to bring the ware out of the lehr at a comfortable handling temperature at these higher speeds.

Because of the smaller size of the lehr for equivalent capacities, the shorter cycle, and the fact that a lower thermal head is carried, requiring less refractory material, it has been possible to reduce the fuel consumption materially. As pointed out earlier in this article, the present fuel consumption is less than 30 per cent of that for muffle-type lehr which was replaced.

While it is too early to give definite information on the maintenance of the new lehr, it is expected that this will be negligible, because other installations of radiant-tube heating elements indicate very slight tube deterioration. The use of heat-resisting alloys in the circulating fan insures that this unit will last throughout the life of the lehr. One item of maintenance cost common to all

lehrs is replacement of the conveyor belt, but by reduced belt tension, improved belt alignment, elimination of rubbing contact with fixed members and avoidance of local overheating, it is expected that belt maintenance will be only a small item.

Since the lehr is a self-contained unit, it may be readily moved. The new radiant-tube lehr was erected beside the old lehr and moved to the site of the old lehr after the latter was dismantled. The sectional construction provides for an increase or decrease of the length of the tunnel, if necessary, to suit changed conditions, and the absence of heavy refractories makes it possible to heat the lehr up rapidly, changing temperatures on short notice to suit changes in production requirements.

The few operating controls have clear-cut functions and the lehr responds quickly to control adjustments. Once the proper conveyor speed and temperature has been determined for a particular item or class of items, the lehr will continue to turn out production on that item with a minimum of attention.

**Development of radiant tubes**

Coils of pipe, internally fired and immersed in cleaning or metal baths (immersion coils), were first applied some 17 years ago and were the logical forerunners of the present-day radiant-tube heating elements applied to industrial furnaces. However, the mere removal of an immersion coil from its moderately hot liquid bath did not turn it into a successful radiant element.

In the development of radiant-tube heating elements, a suitable heat-resisting alloy was never a major problem. Heat-resisting alloy parts, such as pushers, rollers and conveyors, have been successfully used in heat-treating furnaces for a good many years. Since none of the severe operating conditions, such as successive heating and cooling, carrying of loads at high temperatures, and abrasion, are imposed on radiant-tube heating elements, the operating life of these tubes has never been a major problem. In approximately 250 furnaces installations made by the manufacturer of this lehr for both heat treating and enameling, not one tube burnout has been experienced. Three original continuous hardening furnaces, operating at a temperature of 1,650° F and placed in operation in the later part of 1935, are still operating with the original radiant tubes. Earlier in the same year, a batch-type enameling furnace was converted to this form of heating and it also is still operating with the original heating elements. Some slight difficulty has been experienced with leaks at the welds, but this leakage was never serious and was always inward since the tubes are under suction. Improved welding practice has practically eliminated this trouble.

In view of the success of this form of heating in enameling and heat treating furnaces and considering the higher temperatures at which these furnaces operate, it is only reasonable to believe that no trouble should be experienced in the life of these tubes as applied to annealing and decorating lehrs.

While the life of the radiant tubes was never a very serious question in their development, the method of burning the gas inside the tubes had to be carefully worked out. Broadly speaking, there are two forms of combustion, premix and diffusion. In premix combustion, the air and gas are intimately mixed before reaching the burner proper. Upon ignition, combustion is almost instantaneous, taking place with a sharp, short, blue and almost invisible flame. In diffusion combustion the air and gas are usually admitted in parallel layers or strata and unite gradually by the process of diffusion to form a combustible mixture. The flame produced is long and luminous and heat is transmitted chiefly by radiation. Such a flame is well suited for firing radiant tubes, because of the absence of hot spots and the uniform heat release over the entire length of tube. Means have been developed whereby the flame itself is always kept under a negative pressure or suction. Thus, if a small leak should appear in operation, immediate repair of the tube is not necessary and can be postponed until convenient.

The operation of the tube is simple and automatic temperature control devices can be applied readily. The exhaust fan at the discharge end keeps the tube under negative pressure. The suction produced at the burner end causes the gas to unite with the required amount of air for complete combustion at very low velocity and without turbulence. The flame thus secured then proceeds with uniform velocity toward the discharge end of the tube.

It is quite evident that this simple arrangement is more sensitive to automatic regulation than the ordinary refractory with its inherent time lag and resultant heat transfer from the combustion chamber to the muffle. The pick-up of the muffle-type furnace is slow as compared with the fast pick-up of radiant-tube fired furnaces and the amount of effective heat transmitted to the work from the individual tubes is appreciably higher per unit of exposed radiant surfaces, as compared with a refractory muffle.

For higher temperatures, radiant tubes are made of heat-resisting alloys, and for lower temperatures of calorized steel pipe. They can be cast in any commercial shape or form to comply with specifications and design for a given furnace. Chromium-nickel alloys hold their strength remarkably well up to fairly elevated temperatures and, when exposed to oxidizing atmospheres or to sulphur, oxgyen and nitrogen, show no indication of surface deterioration.

The new DeVilbiss lehr was designed and installed by Surface Combustion Corporation of Toledo, Ohio.

**Fig. 5. Discharge end of radiant-tube lehr with old muffle-type lehr in background.**

## ADVENTURES OF A MICROSCOPE

**By Frank W. Preston**

On Wednesday, July 7, I managed to retrieve my petrographic microscope, which I took with me to Canada on May 4. I have been without it since May 13. Many times I have been inclined to weep over the sadness of the customs' officers' lot, for this innocent-appearing microscope seems to have caused an almost infinite number of headaches to both Canadian and U. S. customs officials.

My departure for Canada was hurried. On May 3 I flew to New York and on the 4th from there to Albany, and St. Huberts', Montreal. I had told Mr. Brunning I would bring a petrographic microscope, and he made arrangements with the Federal Government at Ottawa to let it in free of duty for a couple of weeks. Ottawa sent word to this effect to the Montreal customs, and the microscope immediately became a very important article.

I was met at St. Huberts by Mr. Jordan, superintendent of the plant, and by sundry customs and immigration officers. They announced that I should be permitted to work in Canada for two weeks. My personal baggage had only the most trifling interest for them, but it was clear that authority to admit the microscope for two weeks was a puzzle. I opened the case for their inspection, and when they had inspected it casually, locked it up again, and proposed to depart with it, and the rest of my paraphernalia to Mr. Jordan's car. But no, the microscope must travel as far as Montreal, across the river, in the customs' car. Mr. Jordan then offered to take a customs' officer in our car, and this offer was accepted with alacrity, but the microscope must travel as far as Montreal in the customs' car. We were to proceed to an importing agency, who would duly "import" the microscope.

So we proceeded to down-town Montreal, and found the importing agency and signed sundry documents authorizing them to import the microscope, and thereafter we went out to the plant. The microscope however did not show up, and on telephoning the customs next day, they said they could not find the key. That was natural, because it was in my pocket. They had to see inside the case. I explained that they had seen inside it at the airport, and it had been in their custody from the moment I locked it up again. The regulations however apparently called for it to be opened in down-town Montreal, so the inspeciton at the airport did not count. I had to send the key down town and after a while the microscope was "imported" and sent to us, free of duty, but with the request that we give them 24 hours' notice when we proposed to "export" the thing again.

On May 13 I sent them the microscope, key attached, and Mr. Jordan sent a letter with it, announcing my intention, weather permitting, of flying out of St. Huberts on the afternoon of the 14th. The letter got lost and the microscope mislaid.

On the 14th, to check up, we telephoned and discovered that nothing was known about the microscope or its whereabouts, so we went down town to find it for them. This Mr. Jordan succeeded in doing, and the customs authorities agreed, if the plane went, to let me have the microscope with me. But the weather looked bad, and if the plane did not go, and if I went by the night train instead, they could not let me have the instrument in the train, because I might pass it out of the window to an accomplice somewhere between Montreal and Rouse's Point (the border) and then it would not be re-exported at all. Under the circumstances they recommended shipping it in bond to me at Butler, and in view of the weather, Mr. Jordan decided to do this.

The plane was finally cancelled and I did leave by train. I was in New York next morning and Butler that night (May 15).

The microscope did not show up in Butler however. The Railway Express knew nothing about it, and we finally (May 24) phoned Montreal. We were told it was probably in Pittsburgh, but Pittsburgh denied this. More telegrams. Finally the importing house at Montreal discovered they had never shipped it. They said they had gone to special pains to make sure it would go promptly, and in consequence it never went at all. They now shipped it, but before it could reach Pittsburgh, I was in Muncie, Indiana.

We duly (May 27) received word it was in Pittsburgh at the Customs Offices, and would we please pay $70 or so. John McCormick went down with documents to show that it was an instrument purchased in the States, "exported" on May 4 to Canada, and now repatriated. They would not give him the microscope, but gave him a flock of papers to fill out, and for me to sign personally and swear to before a Notary Public. These were sent to me at Muncie, and I did the necessary swearing, and returned them to Pittsburgh. After a little delay, the papers were returned to me; they had to be signed on the back as well as the front, and a notary had to operate on them again.

When I had done this, I returned them once more to Pittsburgh.

I received a notice that 50 cents storage had been incurred. I sent the 50 cents, and a receipt for it came back. But no microscope, or any indication of it.

After a week or two, viz., on June 22, I wrote and asked if something could not be done to liberate the microscope.

No reply was received, but after some days another printed document, more frightful than any previous ones, showed up. The microscope is not properly marked in accordance with the law as to its place of origin. Bring an engraving machine and engrave it according to law. Return all other goods already released to you in error to the Customs House at Pittsburgh, and mark them there. Dire penalties threatened.

I was on the point of leaving for New England when this arrived, and wrote them I would come and see them on my return. I said the thing seemed to be getting into a rut, and if they intended to confiscate the microscope anyhow, please say so at once and don't keep finding new laws to be complied with.

This letter was acknowledged during my stay in New England, the Customs House expressing the belief that all previous forms and printed documents were out of order and beside the point, and enclosing a new one.

Wednesday, July 7 I went to Pittsburgh specially, and interviewed the officers. They were genial and polite and apologized for the dumbness of the Congressmen that make laws. All I had to do was to fill out a form

(*Continued on page* 32)

# DEFECTS IN FOURCAULT GLASS

By ERNST FISCHER, Emmaboda, Sweden

• *As a practical factory manager, Mr. Fischer lists the most common defects in drawn sheet glass, and gives some directions for overcoming them before severe losses are encountered. It may be that our translation of the German vernacular for these defects may give them names not corresponding to glasshouse American, but the descriptions will help to identify them. The Editor.*

*Scum Formation*—The glass surface becomes covered with devitrification crystals, giving a saw-tooth edge to the slot in the debiteuse, which combs the glass sheet into rough stripes. This trouble arises from glass which gets up in the trough of the "debby" and chills there. The glass level, or the glass temperature, have risen too high, or perhaps glass fragments have fallen on the debiteuse from above.

To avoid this scumming trouble, the glass level must be kept constant, also the temperature; and the coolers must be properly placed. Slight scum can be corrected by covering with asbestos that part of the debiteuse where it occurs, until it melts away. But heavy scum must be cut out of the slot, or melted away by throwing in charcoal. The debiteuse must not be submerged, nor allowed to get cool.

*Crooked Sheets*—The glass sheet draws crookedly when the drawing chamber is unequally heated, or false air (parasitic air) is drawn in on one side. When heavy sheets are drawn, the slow movement fails to keep the drawing shaft warm enough, and a bending may result. "Warm cooling water" is recommended.

*Pocked or Branded Sheets*—When the machine is running fast on thin sheets, the glass may go through the first pair of rolls before it is chilled, and thus it clings to, and is marked by, the rolls. The first pair of rolls must now be sprayed, and the water cooling increased. If this does not stop the branding, it may be necessary to slow down.

*Devitrification*—Glass will pass into the crystalline form, or devitrify, when it is held at a favorable low temperature long enough. For a good window glass, this temperature is about 980-1000°C (around 1800°F). Crystals may appear as a slight dimming, as small masses, or the whole sheet may be spoiled by them.

Batch correction is the best prevention. Keep alkali below 15 per cent, but use borax, dolomite [for magnesia] and feldspar [for alumina]. Heating up the drawing chamber once every four weeks, maintaining a high rate of drawing, and perhaps insulating the drawing chamber walls are all helpful.

*Waves and Streaks*—Certain irregularities run lengthwise of the drawn sheets, and become visible when the sheet is viewed crosswise. These are called waves and streaks. They arise primarily from inhomogeneity of the glass mass, and from irregularity in temperature of the glass as it is drawn and as it cools. They are more common after machines have been in operation for some time. They cannot be entirely prevented, but they can be minimized by careful temperature control. No foreign cullet should be used, nor should sudden changes in the batch be made. Also to be avoided are: cooling pipes set too close to the slot; overflowing the slot; temperature variations in the drawing chamber; high speed of the glass in the tank, which requires rapid cooling of the glass mass in a short time, as it comes to the drawing chamber.

*Debiteuse Streaks*—When the debiteuse is cluttered with falling fragments, stones, or the like, or has been fired at such a high temperature that the slot loses form, or is cracked or corroded, it causes streaks in the sheet. The debiteuse should not be heated above 1200°, and in warming up after stopping the machine it should not be carried higher than 1140°C (2080°F). The temperature of the cleaned-out drawing canal should be at about 1130°C (2060°F) before the debiteuse is installed. The debiteuse should be depressed according to the thickness, speed of drawing, and the viscosity of the glass, so that the right quantity of glass is rising through the slot. If, because of temperature rise and overflow, the slot is overflowed, devitrification arises and causes streaking of the glass. If the debiteuses receive too little glass, the glass is dragged out of the slot and is streaked.

*Overflowing*—By this is understood thickening of the sheet over a length of about a foot, in order to stop breakage of the glass. It often is done, when stones or cords arise, to block off the resulting cracks. Frequent overflowing shortens the life of the machine, and causes badly streaked glass. It is best to give up overflowing, and take care of the cracks with burning wooden splinters or by keeping the sheet warm till it reaches the cut-off.

*Bubbles in the Glass*—Bubbles arise from poor melting and refining, or by the method of heating and handling of the new debiteuse in the drawing chamber. The former bubbles are short and broad, and the debiteuse bubbles are stretched out to a length of ten inches or more. If the firing is too low, the gases do not come out of the debiteuses all at once, as is desired, and the glass will be very seedy. Therefore, it is advisable to invert the debiteuse at once, when it is set, and heat it for ten hours at 1170°C (2140°F) and to skim carefully. If the bubbles are a melting defect, the pull must be slowed down, to give it more refining time. No dirty or iron-bearing cullet should be used.

*Contraction*—The sheet becomes contracted if there are stones or cords in the glass, or if the cooling is so rapid that unequal tension is set up. The temperature at the first pair of rolls ought to be about 930°F, and in the middle of the drawing shaft, about 390°F, for a suitable temperature gradient. Contraction will also occur if the glass mass is not homogeneous, if too much cullet or foreign cullet of different composition is added, if the temperature of the drawing chamber is too high, or if the rolls are very hard or very heavily loaded. Borax, feldspar, or dolomite in the batch help prevent the glass from becoming short-natured.

*Stoppage*—If the glass flows clear out of the debiteuse, and overflows the slot, stoppage results. This also happens if the glass in the drawing chamber is overheated, and thus becomes so fluid that more glass comes into

*Condensed from *Sprechsaal*, Sept. 23, 1937.

the debiteuse than can be drawn out. Likewise, the same result follows, if the glass level gets too high, because of too rapid charging, or if the driving motor is stopped by an interruption of the current. It is advisable to have auxiliary storage battery service to take care of temporary current failures.

*Hairlines*—Thread-like streaks in the drawing direction may occur in the sheet. The cause is either aluminous glass or some tendency of the glass toward devitrification. Alumina arises from corrosion of the blocks, producing a viscosity differing from that of the rest of the glass. This is accentuated by having the floaters too hot, or having batch piles floating too near the sidewalls, especially with inferior blocks. If the hairlines come from devitrification, the above mentioned additions to the batch will help; but if they come from alumina, one must operate at a lower melting temperature, and look out for the position of the floaters. The underbridge may also be of poor quality, and send in alumina.

*Seedy Glass*—If "dusty" seeds, up to the size of a pin head, are present, they may arise from poor refining, a bad batch, impure cullet, lack of refining agents, or too much coal, too low temperature, defective charging, or a stagnant bottom layer. These things are remedied by correction of the batch, and by the adjustment of the burners. The batch balls must not be permitted to travel too far forward before melting, and must be retained in the middle of the tank. Sufficient melting area must be provided, up to 200 sq. ft. for each machine.

*Chilled Borders*—If proper heating up and cleaning is not done after a stoppage of the machine, or if at the start no asbestos is laid on the debiteuse, or if the onion draws more on one side, through improper regulation of the cooling air at the edges, chilled borders will result. This defect must be immediately corrected. Proper dimensioning and construction of the slot will provide for proper amount of glass flowing at the ends of the slot, which prevents this chilling. Perhaps the cooling water is too cold, or the observation holes have cooled the edges too much, or the drawing chamber may be at too low a temperature, so that the glass at the ends of the sheet flows too slowly and becomes continuously too cold. Glass composition plays an important role. The glass may be too poor in alkali, or too rich in lime. The glass may be warmed by putting charcoal beside the onion, while drawing speeed is temporarily reduced.

*Separating Borders*—When the sheet comes out of the drawing shaft, the edges always cool faster than the middle portion. Tension is set up, which tends to pull the edges away. If this tension is great enough, the border slits off, and the sheet cracks apart. As a correction, the temperature of the drawing shaft must be adjusted, so that there will be no unequal cooling from observation holes or side openings, and at times the borders must be cut off while the sheet is still warm. If the temperature of the drawing shaft is retained uniform, by the use of proper instruments, the borders will be free from tension and can be smoothly cut off as usual when the sheet reaches the cold condition.

## WINDOW GLASS MANUFACTURERS DISSOLVE

The Window Glass Manufacturers Association has been dissolved, according to an announcement by W. L. Monro, president of the association and head of the American Window Glass Co. Members included Libbey-Owens-Ford, Pittsburgh Plate and Fourco Sales, in addition to American Window Glass. Mr. Monro said the action was taken on advice of attorneys after the Federal Trade Commission had issued a cease and desist order banning certain trade practices.

Although charges of unfair price regulation by the manufacturers were withdrawn by FTC, the long established custom of quoting different prices to a qualified buyer (i.e., one who orders large shipments) and a carload buyer was banned.

Mr. Monro told the New York *Herald-Tribune*, "No action to raise or lower prices by window glass manufacturers as a group can or will be taken. It would be a violation of the Federal Trade Commission's order and no manufacturer would court trouble with the Commission. There is no price agreement at the present time and there can be none in the future."

## ABSTRACTS OF BRITISH PAPERS

(*Continued from page* 22)

There was a sharp break in the region of the sodium disilicate composition giving a pronounced minimum at this point in a manner exactly analogous to that found by C. H. Herty and co-workers in the $CaO$-$SiO_2$ system.

These findings indicated that the vapor-pressure of volatilizing alkali would be less on either side of the disilicate composition, in agreement with the fact that the vapor pressure of any substance is lowered by the presence of materials in solution. Two systems were thus obtained, namely, an S-shaped viscosity-composition curve between $SiO_2$ and $Na_2O.2SiO_2$, and a curve showing a maximum near to 35 per cent $Na_2O$ between $Na_2O.2SiO_2$ and $Na_2O.SiO_2$. The curve for this latter system was analogous to that for water-acetic acid, the viscosity-composition curve showing a pronounced maximum at 80 per cent acetic acid.

The effect of dentrification was investigated.

The conclusions were discussed in the light of recent research on these glasses. It could not be doubted that above the liquidus temperatures the compounds $Na_2O.2SiO_2$ were still present in the liquid state. Further, it was fundamentally erroneous to assume that the liquid phase was simply a mutual solution of $Na_2O$ and $SiO_2$ when compounds were present in the solid condition.

## NOVEMBER PLATE GLASS PRODUCTION

The production of polished plate glass by member companies of the Plate Glass Manufacturers of America during Nov., 1937, was 12,517,311 sq. ft. as compared to 14,854,918 sq. ft. produced in Oct and 13,083,963 sq. ft. produced in the corresponding month last year, Nov. 1936. This makes a total of 183,671,791 sq. ft. produced during the first eleven months of 1937.

## SILVERMAN MAKES LECTURE TOUR

On Jan. 21, Dr. Alexander Silverman of the University of Pittsburgh will address a joint meeting of the Chicago sections of the American Ceramic Society and the American Chemical Society. Dr. Silverman's subject will be recent developments in glass. On Jan. 17, he will address the Iowa City section and on Jan. 19 the Ames, Iowa, section of the American Chemical Society.

# GLASS NEWS FROM ABROAD

### Belgium

Window glass factories are still working short-time as a result of the disorganization of the export market. The usual seasonal demand has not been felt at all. Plate glass works are in a similar position. It has proved impossible to maintain last year's volume of production and though prices have been advanced slightly, they do not cover the increased costs.

The National Committee of the Belgian Glass industry has decided to close all glass plants for a two weeks term during the month of January. Only a small portion of the workers will be retained in the mills to keep the stoves under operation.

### Czechoslovakia

The Gablonz industry is suffering from the disturbed state of foreign markets. It was expected that the removal of Japanese competition would help exports, but so far these hopes have not been justified. Exports are unlikely to exceed 225 million Czech crowns in value.

The hollow glass works, on the other hand, are still busy. Orders for next year are satisfactory and export business is good. The Rudolfshuette near Falkenau in Northern Bohemia for instance, will be producing again shortly. The output of hollow glass is being expended throughout the country.

### France

A deputation representing all sections of the glass industry was received by the French Permanent Undersecretary for Commerce. The perilous situation of the industry in face of foreign competition was discussed and on behalf of the Government it was stated that the views of the industry as well as the actual economic position, would be sympathetically examined.

### Germany

The glass industry is profiting by the shortage of metals and a large variety of new types of wares are being produced. Glass cooking utensils and other culinary articles, glass plates and other table ware, glass instead of metal in the packing industry and a wide range of glass furnishings are finding ready markets, thanks to the Government publicity campaigns. The demand for plate glass is good and production for the first three-quarters was up eight per cent over last year. The seasonal demand, however, has not been so heavy as usual. Spun glass is being produced in ever larger quantities and the demand for special types of goods, industrial retorts, etc., is good.

Attention is being paid to export business. Railway freight rates to frontier stations have been specially reduced.

### Italy

Glass exports to the end of Aug., 1937, were valued at 25,210,000 lire against imports of 19,490,000 lire, compared to the full year 1934, when exports were only 18,860,000 lire and imports 38,120,000 lire. During that period the output of the hollow glass industry has increased from 300 million lire to 500 million. The expansion continues in the founding of two new firms, Vetroceramica Napoletana and La Silicea; one for the manufacture of hollow glass ware, the other to mine silica.

### Japan

Sanction has been obtained from the Manchukuo Government by the Asahi Glass Works to set up a subsidiary at Mukden. The firm has been incorporated as the Shoko Glass Konsu. A plant with a designed output of 500,000 cases a year is already under construction.

A draft ministerial ordinance providing for the restriction and prohibition of imports has been approved by the Trade Inquiry Commission for immediate promulgation. The articles of which importation has been prohibited for the duration of the current wartime economy include plate or sheet glass, plate glass having inlaid wire, spectacles and eye-glasses, glass manufactures "not otherwise provided for" in the Customs Tariff.

The Tokunaga Glass Co., Japan's No. 1 bottle producer, is rushing preparations for manufacture of plate and sheet glass at the annual rate of 200,000 cases. Tokunaga is the sixth firm to enter plate glass manufacture in Japan. And when Tokunaga commences operations, it is predicted that production in Japan will amount to some 6,000,000 cases annually.

The Japan Plate Glass Co. reportedly has decided to take up production of special glass including safety glass, steel glass and others, at the Yokkaichi plant of the company in Mie prefecture. It may be noted that special kinds of glass such as safety glass and steel glass are grouped under Class A in the recently promulgated Industrial Fund Adjustment Law, while ordinary plate glass is included in Class C as being non-urgent in nature. Class A industries may expand unconditionally, while government license is required for capital adjustments of Class C industries.

### Puerto Rico

Puerto Rico, now the third largest buyer of glass and glass products shipped from the United States, promises to become a still more important customer if the increase in the Island's rum shipments continue. The Puerto Rican Trade Council says that sales of glass products in the past fiscal year showed an increase of 60 per cent and a further increase of 55 per cent during the first eight months of 1937. Unfilled glass containers account for about two-thirds of the total shipments with table glassware in second place and plate and flat glass third. Inasmuch as Puerto Rico is a part of the United States and subject to all tariff regulations, it seems certain that American manufacturers will retain a large share of the business.

### Russia

The plate glass industry has been thoroughly re-organized and re-equipped and now compares favorably with other European glass industries. At the same time an Institute of Glass Technology has been founded in Moscow to undertake scientific research. One of its first successes is the production of safety glass from a solution of sodium silicate and casein. The mixture is subjected to a pressure of 14 kilos per $cm^2$ at 100° C for three minutes.

# CURRENT PRICES OF GLASS-MAKING MATERIALS

**FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS**

## Base Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh | ton | 43.00 | 46.00 |
| Barium sulphate, in bags | ton | 19.00 | 24.00 |
| Barium sulphate, glasamaker's, carlots, bulk f. o. b. shipping point | ton | 15.00-16.00 | 18.00 |
| Borax ($Na_2B_4O_7 10H_2O$) | lb. | .... | .... |
| Granulated | In bags, lb. | .021 | .0255-.028 |
| Powdered | In bags, lb. | .0235 | .028-.0305 |
| Boric acid ($H_3BO_3$) granulated | In bags, lb. | .0475 | .0525-.055 |
| Calcium phosphate ($Ca_3(PO_4)_2$) | lb. | .07 | .07⅛ |
| Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith) | lb. | .0875 | .0925 |
| Synthetic (Artificial) | lb. | .0875 | .0925 |
| Feldspar— | | | |
| 20 mesh | ton | 11.00-13.25 | |
| 40 mesh | ton | 11.50-13.75 | |
| Granular | ton | 11.75-14.00 | |
| Semi-granular | ton | 11.00-13.25 | |
| L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags | | | |
| Fluorspar ($CaF_2$) domestic, ground, 96-98% (max $SiO_2$, 2½%) | | | |
| Bulk, carloads, f. o. b. mines | ton | 31.50 | .... |
| In bags | ton | 33.10 | 38.00-40.60 |
| Kryolith (see Cryolite) | | | |
| Lead Oxide ($Pb_3O_4$) (red lead) (N. Y.) | lb. | .075 | .... |
| In 5 Ton lots | lb. | .... | .08 |
| Less than 5 Tons | lb. | .... | .085 |
| Lime— | | | |
| Hydrated ($Ca(OH)_2$) (in paper sacks) | ton | 10.50 | .... |
| Burnt (CaO) ground, in bulk | ton | 7.00 | .... |
| Burnt, ground, in paper sacks | ton | 9.00 | .... |
| Burnt, ground, in 280 lb. bbls. | Per bbl. | 2.25 | 2.25 |
| Potassium carbonate— | | | |
| Calcined ($K_2CO_3$) 96-98% | lb. | .065 | .0675 |
| Hydrated 80-85% | lb. | .055 | .0575 |
| Salt cake, glassmakers ($Na_2SO_4$) | ton | 18.00 | 27.00 |
| Soda ash ($Na_2CO_3$) dense, 58%— | | | |
| Bulk | Flat Per 100 lb. | .95 | .... |
| In barrels | Per 100 lb. | 1.35 | .... |
| In bags | Per 100 lb. | 1.10 | .... |
| Sodium nitrate ($NaNO_3$)— | | | |
| Refined (gran.) in bbls. | Per 100 lb. | .... | 2.50-2.90 |
| 95% and 97% | | | |
| Bulk | Per 100 lb. | 1.35 | .... |
| 200 lb. bags | | 1.415 | 1.44 |
| 100 lb. bags | | 1.45 | 1.475 |

## Special Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Aluminum hydrate (Al $(OH)_3$) | lb. | .... | .03½ |
| Aluminum oxide ($Al_2O_3$) | lb. | .04 | .05 |
| Antimony oxide ($Sb_2O_3$) | lb. | .15 | .15½ |
| Arsenic trioxide ($As_2O_3$) (dense white) 99% | lb. | .03 | .03¾ |
| Barium nitrate ($Ba(NO_3)_2$) | lb. | .... | .07¾ |
| Rutile ($TiO_2$) powdered, 95% | lb. | .11-.12 | .13-.15 |
| Sodium fluosilicate ($Na_2SiF_6$) | lb. | .05½ | .06 |
| Tin Oxide ($SnO_2$) in bbls. | lb. | .... | .48 |
| Zinc Oxide (ZnO) | | | |
| American process, Bags | lb. | .06¾ | .06½ |
| White Seal, 150 lb. bbls. | lb. | .08¾ | .09 |
| Green Seal bags | lb. | .08 | .08¼ |
| Domestic White Seal bags | lb. | .08½ | .08¾ |
| Red Seal, bags | lb. | .07½ | .07¾ |
| Zircon | | | |
| Refined Granular (Milled .005-.02c higher) | | .07 | 0.7½-.08 |
| Commercial, Gran. (Milled .005-.02c higher) | | .03 | .04-.05 |

## Coloring Materials

| | | Carlots | Less Carlot |
|---|---|---|---|
| Barium selenite ($BaSeO_3$) | lb. | .... | 1.50-1.75 |
| (Commercial, 25% Selenium) | lb. | .... | .90 |
| Cadmium sulphide (CdS) | lb. | .... | 1.25-1.35 |
| Chromite (99% through 200 mesh) | lb. | 37.00 | 40.00 |
| Cerium hydrate | | | |
| 100 lb. drums and 600 lb. barrels | lb. | .... | .60 |
| Chrome Oxide Green, 400 lb. bbls. | lb. | .... | .22-.26 |
| Cobalt oxide ($Co_2O_3$) | | | |
| In bbls | lb. | .... | 1.67 |
| In 10 lb. tins | lb. | .... | 1.77 |
| Copper oxide | | | |
| Red ($Cu_2O$) | lb. | .... | .20¼ |
| Black (CuO) | lb. | .... | .15½-.18½ |
| Black prepared | lb. | .... | .22 |
| Iron Oxide— | | | |
| Red ($Fe_2O_3$) | lb. | .... | .0425 |
| Black ($Fe_3O_4$) | lb. | .04½ | .... |
| Iron Chromate | lb. | .... | .035-.05 |
| Lead Chromate ($PbCrO_4$) | lb. | .... | .16 |
| Manganese, Black Oxide | | | |
| In Paper bags | ton | 57.00 | 64.50-66.50 |
| In Burlap bags | ton | 65.50 | 67.50-69.50 |
| In Casks | ton | 70.50 | 72.50-74.50 |
| Neodymium oxalate, 50 lb. drums | lb. | .... | 3.50 |
| Nickel oxide ($Ni_2O_3$), black | lb. | .... | .35-.40 |
| Nickel monoxide (NiO), green | lb. | .... | .35-.40 |
| Potassium bichromate ($K_2Cr_2O_7$)— | | | |
| Crystals | lb | .08⅛ | .0925 |
| Powdered | lb. | .... | .0975 |
| Potassium Chromate ($K_2CrO_4$) 100 lb. kegs | lb. | .... | .27 |
| Powder blue | lb. | .... | .2075 |
| Rare earth hydrate | | | |
| 100 lb. drums | lb. | .... | .35 |
| 325 lb. barrels | lb. | .... | .30 |
| Selenium (Se) In 100 lb. lots | lb. | .... | 2.00 |
| In lesser quantities | lb. | .... | 2.10 |
| Sodium bichromate ($Na_2Cr_2O_7$) | lb. | .06⅞ | .0725 |
| Sodium chromate ($Na_2CrO_4$) Anhydrous | lb. | .08¼ | .08½ |
| Sodium selenite ($Na_2SeO_3$) | lb. | .... | 1.80-2.00 |
| Sodium uranate ($Na_2UO_4$) Orange | lb. | .... | 1.50-1.55 |
| Yellow | lb. | .... | 1.50-1.55 |
| Sodium uranyl carbonate | lb. | .... | .80-.90 |
| Sulphur (S)— | | | |
| Flowers, in bbls. | Per 100 lb. | 3.35 | 3.70-4.10 |
| Flowers, in bags | Per 100 lb. | 3.00 | 3.35-3.75 |
| Flour, heavy, in 250 lb. bbls. | Per 100 lb. | 2.90 | 3.25-3.65 |
| Uranium oxide ($UO_2$) (black, 96% $U_3O_8$) 100 lb. lots. Black | lb. | .... | 2.25 |
| Yellow orange | lb. | .... | 1.50 |

## Polishing Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Emery, Turkish | lb. | .... | .07 |
| Pumice Stone, | | | |
| American Ground Italian FFF, FF, F | lb. | .... | .03 |
| 0, 0½, ½, 1. | lb. | .... | .03¾ |
| Putty Powder | lb. | .... | .38-.42 |
| Rotten Stone | lb. | .... | .03 |
| Rouge, Red | lb. | .... | .14 |
| Black | lb. | .... | .16 |

# EQUIPMENT AND SUPPLIES

## BROWN PNEUMATIC TRANSMISSION SYSTEM

A pneumatic transmission with air-operated control, for remote measurement, has recently been brought out by the Brown Instrument Co., Philadelphia. The device has been designed primarily for use in explosive atmospheres, or under other conditions where electrical measurement is not permissible. The device consists essentially of a transmitting indicating instrument at the point of operation, and a receiving indicator or recorder located at the remote master control board and shown at the right. The two instruments are connected by a length of transmission tubing, the transmission unit being a simple, balanced air pilot built into the indicating transmitter and mechanically actuated. It is stated that the device will give a definite pressure response for less than 1/10 per cent of full-scale movement of the measuring element and that the receiver records less than 1/5 per cent change. A temperature change of 60 degrees is said to affect less than ¼ per cent and a 1 per cent change in metered value can be transmitted 200 feet in less than one second. Full scale change takes approximately 20 seconds.

## MODERN REFRACTORY PRACTICE

"Modern Refractory Practice" is the second edition of a practical handbook published by Harbison-Walker Refractories, Pittsburgh. While it follows the general lines of the first edition, published in 1929, the book has been completely rewritten and increased in size from 180 to 296 pages. Sixteen full-page drawings have been prepared on the basis of current industrial practice and all standard types of refractories are said to be shown.

A chapter, "Refractories and Their Properties," gives basic technical data on the composition, structure and properties of refractories as affected by furnace temperatures, furnace gases and slags.

The price of the book is $2.50 but it is offered without charge to users of refractories.

## BINNEY MOVES

An announcement by W. F. Donovan of the Binney Castings Co., Toledo, stated that the company expected to occupy its new plant during the month of December. This new plant was built by the Austin Co., Cleveland, and is located at Dorr St. and the N. Y. C. old-line railroad. The new layout has been planned especially for the production of alloy castings which are used extensively for glass-machine moulds, etc. Glass block has been used in the offices of the new plant and the foundry arrangement has been planned for the maximum comfort, safety and convenience of the workmen.

## PERSONNEL CHANGES

The Cambridge Wire Cloth Co., Cambridge, Md., has appointed George B. Fletcher sales engineer for the Pittsburgh territory. Mr. Fletcher will cover West Virginia, Eastern Ohio, Western Pennsylvania, and western part of New York State. Mr. Fletcher's business address is The Investment Bldg., Pittsburgh, Pa.

Ralph R. Shultz has been appointed traffic manager of Basic Dolomite, Inc., Cleveland, with headquarters at the company's Cleveland offices, 845 Hanna Building. Mr. Shultz brings to Basic Dolomite a wide knowledge of traffic obtained from both railroad and industrial connections.

The appointment of T. M. Robie as manager of the Diesel sales division of Fairbanks, Morse & Co., effective Nov. 1, has been announced by A. C. Dodge, vice-president in charge of sales. Mr. Robie has been associated with Fairbanks-Morse since he returned from World War overseas service in 1919, serving in numerous capacities in the manufacturing and sales division. Since 1932 he had been in charge of Diesel sales to resale manufacturers.

The Board of Directors of the Vitro Manufacturing Co., Pittsburgh, recently elected E. M. Fleck, president and chairman of the board, and A. J. Strod to the vice-presidency. Mr. Fleck, formerly vice-president, succeeds the late Josef Volkommer. Mr. Strod, who was sales manager, will continue to have complete charge of sales.

## CATALOGS RECEIVED

*The Commercial Shearing & Stamping Co.*, Youngstown, Ohio. Tank heads, tank accessories and special stampings are described and illustrated in a 28-page catalog.

*The Mathieson Alkali Works*, 60 East 42nd St., New York. A beautifully illustrated 36 page booklet traces the development of the company and gives concise information and package specifications on a wide variety of products. Flow charts outline the processing operations at the company's different plants. Another interesting chart lists the users and uses of the company's products.

*Thwing-Albert Instrument Co.*, 3339 Lancaster Ave., Philadelphia. Leaflet A3716 illustrates and describes "The Thwing Treasure Chest," an instrument for checking thermocouples and all types and makes of pyrometers. This portable device operates on the potentiometer principle and may be used in the laboratory or in the plant.

*The Northern Blower Co.*, 6409 Barberton Ave., Cleveland. Bulletin No. 1002-3 gives complete information about the improved high-speed "Norblo" exhaust fans. The bulletin includes tables of dimensions and capacity, as well as full description and illustrations.

*Fairbanks, Morse & Co.*, 900 S. Wabash Ave., Chicago. Bulletin 1410 illustrates and describes three types of vertical motors built by this company. Type QSZU has a solid shaft and Types QSZV and QZV have hollow shafts, the latter having weather-proof construction. All these motors are of the squirrel-cage type.

*The International Nickel Co., Inc.*, 67 Wall St., New York. An 8-page list of current publications on the uses and properties of nickel, any of which will be supplied by the company to production men, engineers and metallurgists. The subjects include uses in industrial fields, alloy production procedure and reference data.

*Leeds & Northrop Co.*, 4901 Stenton Ave., Philadelphia. Folder No. F-T625(4) explains the operation of the Homo tempering furnace in hardening small non-ferrous pieces, the furnace also being adapted for the annealing of small glass items of a special nature.

*Binks Spray Systems.* Catalog No. 173. Binks Manufacturing Co., 3114 Carroll Ave., Chicago, Ill. A well-illustrated, loose-leaf book which combines engineering data, instruction sheets and parts price lists on the complete line of Binks spray painting and finishing equipment. Items covered include spray guns, compressors and accessories; complete spray painting outfits; spray booths and accessory equipment.

*American Instrument Co.*, 8010 Georgia, M Ave., Silver Spring, Md. Catalog No. 38GI is a 100-page book entitled "Chemical and Biological Laboratory Instruments." It presents information on the latest developments in the company's scientific instruments.

## LAGGING FOR PULLEYS

Rockwood Manufacturing Co., 1801 English Ave., Indianapolis, is now marketing fibre laggings for drive pulleys and fly-wheels, in any width and up to 72 in. in diameter. The laggings may be used to increase the diameter of belt pulleys and are locked on by means of an improved clamp. The belt speed of a drive may be increased by lagging both the driving and driven pulleys, or the speed of the driven machine may be increased or decreased by enlarging either the driving or driven pulley alone. These fibre laggings are made of the same material as the Rockwood paper pulleys, which are extensively used as standard equipment on electric motors.

### ADVENTURES OF A MICROSCOPE

(*Continued from page* 26)

saying this microscope was part of my professional equipment, had been mine before going to Canada, and was not now intended for resale, and it didn't matter whether it was engraved or not with its country of origin, or anything else.

This done, they gave me another form to get the microscope from the Appraiser's office. The Appraiser greeted me in a friendly way and gave me another form to sign. I held this in my right hand while he found the microscope, and then he traded me the microscope for it. It had labels all over the case.

I made tracks for the elevator, and the elevator boy protested; he couldn't take me down with that instrument unless I had a permit. Nothing could go out of the building without a permit. I told him I had been signing permits for two months, and finally he consented to let me go.

When I got to Butler that evening, I found a letter from the Treasury Department at Pittsburgh, acknowledging my letter of June 22. "Our records do not indicate that any microscope of yours is impounded here. We presume it is still in Canada and suggest you get in touch with the Canadian authorities."

### NEW A. G. A. CERAMIC COMMITTEE

Oliver Lloyd Maddux, United Gas & Fuel Co., Ltd., Hamilton, Ont., has been made chairman of the ceramic industries committee of the industrial gas section, American Gas Association. This announcement by Hales A. Clark of Detroit, section chairman, also announced the appointment of George M. Parker, Mississippi River Fuel Corporation, St. Louis, as vice-chairman. Philip Dressler, Swindell-Dressler Corporation, Pittsburgh, is also a member of this committee, which will serve until Sept. 30, 1938.

### A. S. T. M. STANDARDS ON REFRACTORY MATERIALS

The 1937 manual of *A. S. T. M. Standards on Refractory Materials* gives in latest form all of the specifications, test methods and definitions in this field, as developed by the American Society for Testing Materials. In addition to all standards, the detailed methods for interpretation of refractory test data are included. There are also comprehensive surveys showing service conditions for refractories in important consuming industries, including glass, together with details of standard samples of refractory materials. An important new section covers a recommended procedure for calculating heat losses through furnace walls. Copies of the new, 180-page manual can be obtained from A. S. T. M. Headquarters, 260 S. Broad Street, Philadelphia, at $1.25 per copy.

### FEDERAL GLASS ELECTS

At a recent meeting of the Board of Directors of the Federal Glass Co., Columbus, Ohio, E. A. Donnan was elected to the presidency of the company. Mr. Donnan has been with Federal for the past 17 years. At the same meeting, U. L. Conway, formerly assistant vice-president and general sales manager, was promoted to vice-president and director of sales. Mr. Conway was also elected to the Board of Directors to fill a vacancy.

### 90.3 PER CENT OF PACKAGED BEER IN GLASS

A nation-wide survey of the Glass Container Association revealed that in July 90.3 per cent of the nation's packaged beer went into glass. The actual survey was conducted by the well-known Ross-Federal Market Research Corporation from reports submitted by 567 of the 679 brewers who were licensed and producing malt beverages in July. Of this 90.3 per cent, the export bottle took 55.0 per cent; Steinie jumped up to 24 per cent; the quart took 4.1 per cent; the half-gallon, 3.8 per cent; the Stubby 2.8 per cent. Six-tenths of one per cent of the beer went into miscellaneous packages, and the tin can took 9.7 per cent.

• Announcement was made, Dec. 9, of the appointment of D. C. Burnham as Manager of Glass Block Sales for the newly formed Pittsburgh Corning Corporation, Grant Building, Pittsburgh, Pa. Prior to his appointment as manager of the Boston warehouse Mr. Burnham served as Manager at Philadelphia and Atlanta and as Assistant Manager at Chicago.

• The Lincoln tunnel, between New York City and Weehawken, N. J., was dedicated, Dec. 21, and thrown open to toll-paying traffic the following day. This tunnel is of interest to glass men because it is the first to be built with a glass roof, some 800,000 pieces of glass tile being used in the construction. The design of the tiles and the method of holding them in place in the concrete was described in the January, 1936, issue of THE GLASS INDUSTRY. The New York entrance of the tunnel is at Dyer Ave. and 36th Street.

BINNEY

MIN-OX
RESISTS SCALE

**The Best for Glassware**

• MIN-OX is made exclusively for glass moulds and produces glass of greater brilliancy and clarity. Fidelity of design is assured.

• MIN-OX moulds have a long life and practically eliminate fire-finishing—reduce cleaning costs and spoiled ware—and generally lower production costs.

• MIN-OX moulds produce more saleable products at a lower production cost.

**Write now for complete details.**

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THE BINNEY CASTINGS COMPANY
TOLEDO, OHIO
*originators of alloys for glass molds*

DESIGNS
MODELS
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Quality and Quick Service
....350 EMPLOYEES
OVERMYER
MOULD COMPANY
WINCHESTER, IND.

CALCIMAG
PATENTED
A CLINKERED DOLOMITE
FOR THE GLASS BATCH...

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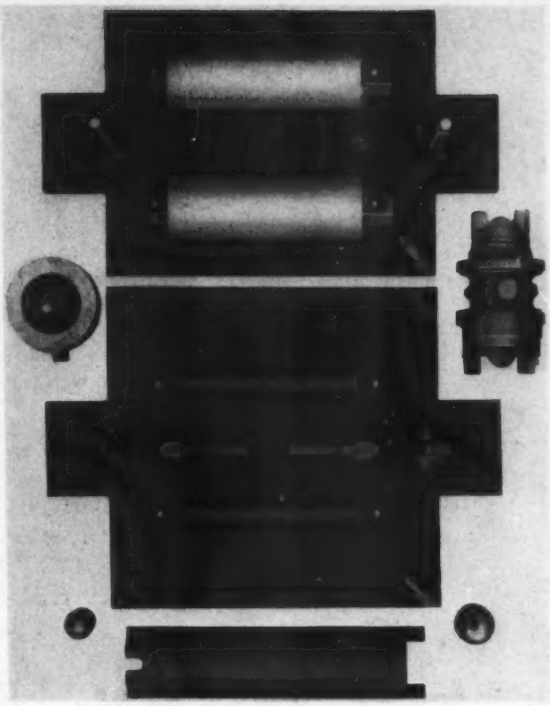

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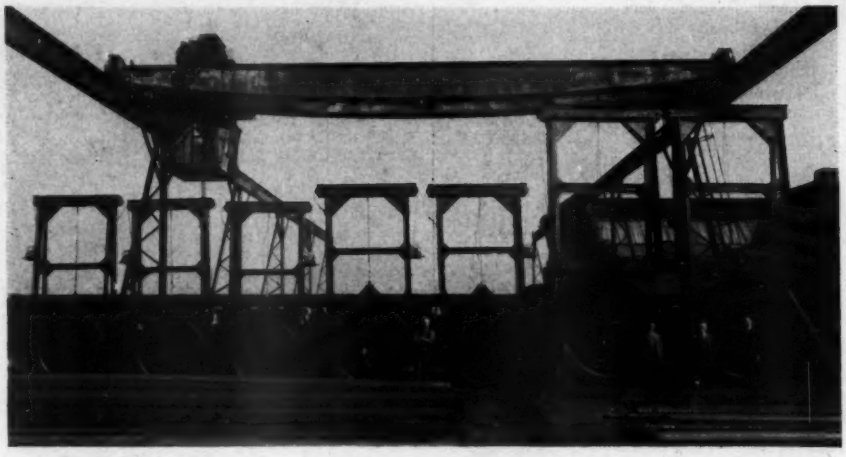

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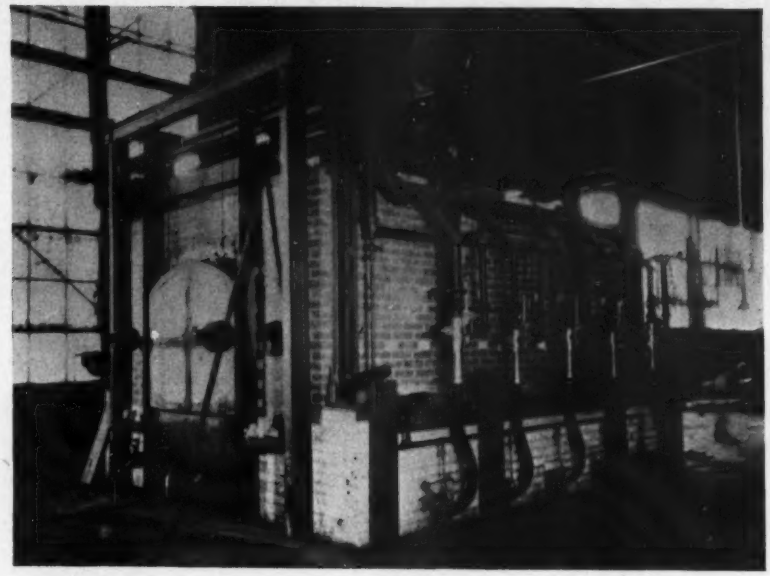

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